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Combined Generating and Substation

LATEST HYDROELECTRIC DEVELOPMENT OF NEW ENGLAND POWER CO.; MOTOR GENERATORS EQUIPPED WITH WATER WHEELS CAPABLE OF UTILIZING ALL OF AVAILABLE ENERGY OF DEERFIELD RIVER

IN THE DECEMBER 1st and 15th, 1913, issues of this paper, considerable space was devoted to a detailed description of the Connecticut River and Deerfield River Developments, operated by the Connecticut River Transmission Co., under the caption "Shelburne Falls Power Plants," wherein brief mention is made of Plant No. 5, then used as a transformer and frequency-changer station. At that time this installation was primarily employed to supply current for the Boston & Maine R. R., Hoosac Tunnel electrification located approximately 3 miles below. Energy was received from the company's transmission system at a voltage of 66,000 and a frequency of 60, and converted and transmitted to the railroad at 11,000 v., 25 cycles single-phase.

This plant has now been completed, and while the 25-cycle current is still obtained from the same machines, they, together with the 60-cycle machines, are driven by recently installed water turbines, the 60-cycle units now, under normal conditions, feeding the surplus energy developed into the general transmission system. There are times, however, as when the supply of water is low or operating conditions so require, that the 60-

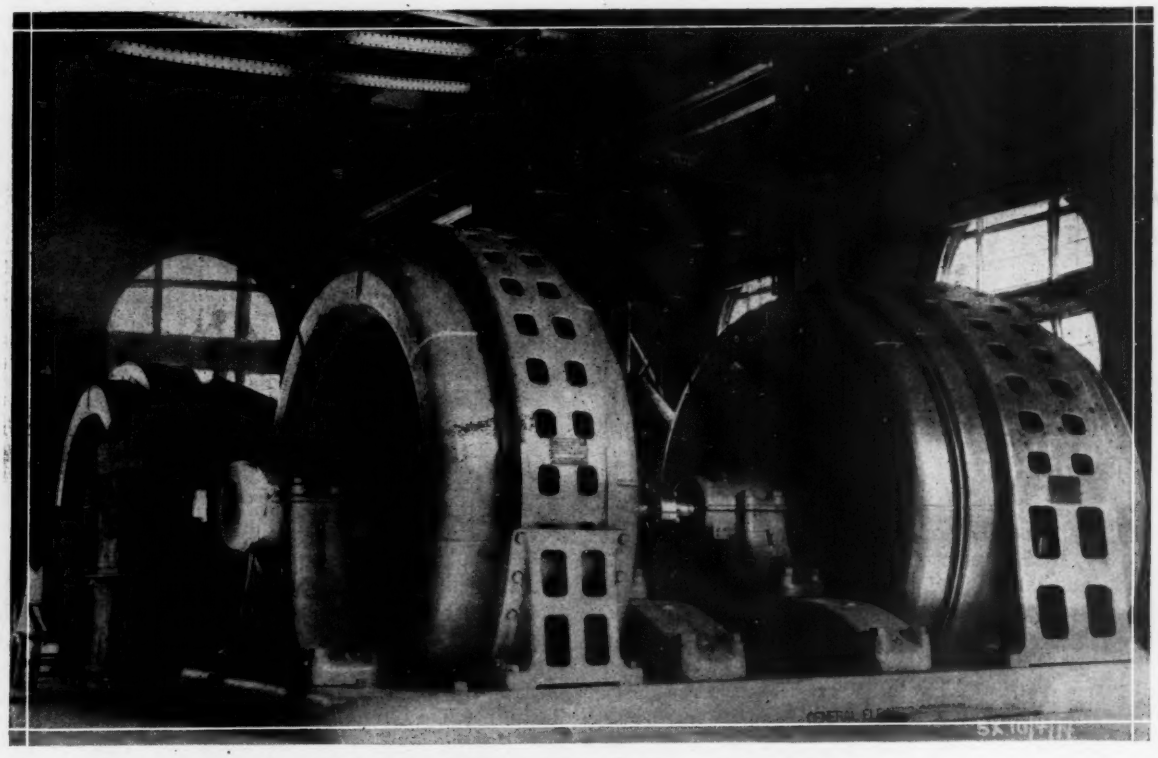


FIG. 1. GENERATING UNITS, STATION 5, NEW ENGLAND POWER CO.

cycle units will draw current from the line to drive the other machines and during which periods some turbines must run idle. Contrary to what may be expected under such conditions of shifting load from system to turbine and from turbine to system, this change is accomplished without shutting down and without even a variation of speed. These changes are made very smoothly and the turbine governors are placed in operation without causing any disturbance in the speed of the machine or the system in general.

From the Somerset Reservoir near the southern boundary of Vermont, the waters of the Deerfield River flow to a point just below Monroe Bridge, Mass., where

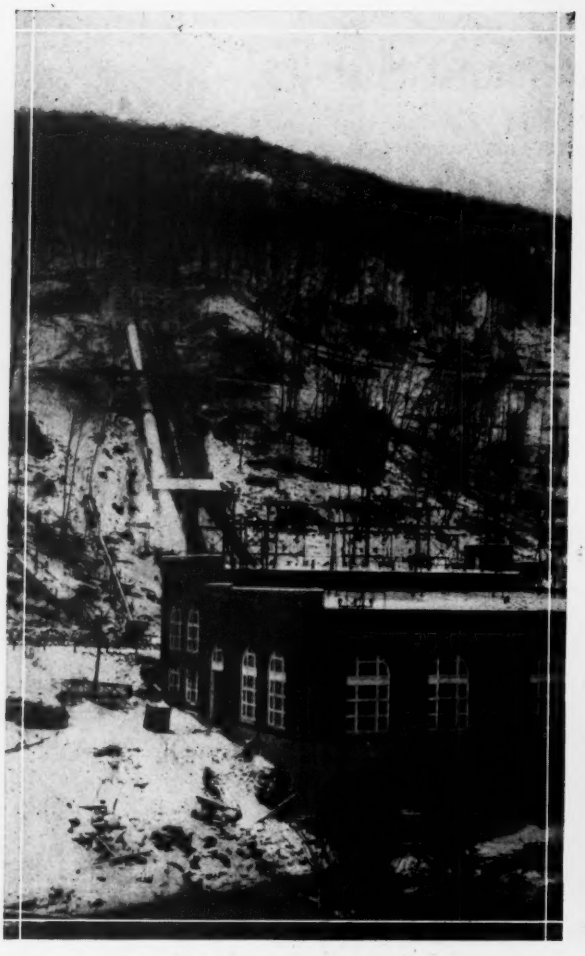


FIG. 2. EXTERIOR OF STATION WITH CONDUIT, SURGE TANK AND PENSTOCKS IN BACKGROUND

a spillway dam diverts the water through a tunnel to alternate sections of reinforced concrete conduits and open canals along the right bank of the river to a surge tank located on a slope directly above the power plant 3 miles down stream. The flow of water into the tunnel at the dam is controlled by a motor-operated head gate built up of structural steel filled with concrete as shown in Fig. 7. There are 2 submerged waste gates, also motor operated, and the 3 gates are included in a structure the general construction of which may be noted by referring to Fig. 6. From here, as stated, the water is passed through alternate sections of open canals and reinforced concrete conduit, the latter being made of a 9-in. concrete shell above the horizontal axis and somewhat heavier concrete below with the whole reinforced with longitudinal and circumferential reinforcing rods. All circumferential reinforcing rods were electrically welded and by leaving the welding burr on the constructing engineers found from tests that the joint has a

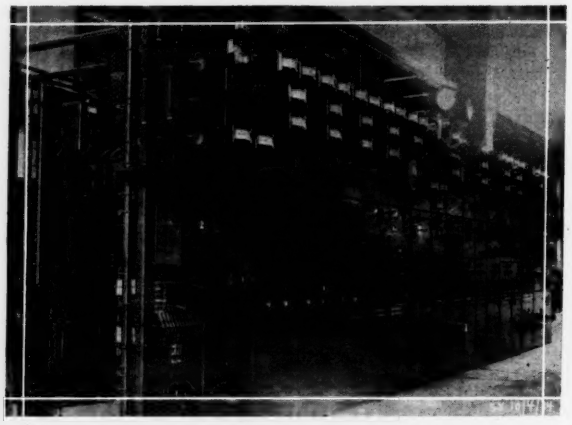


FIG. 3. ELECTRICAL CONTROL BOARD

strength greater than that of the normal section of the rod. In Fig. 8 is illustrated a section of this conduit in course of construction.

Water enters the rectangular shaped surge tank near the front through a connection, making an angle of about 45 deg., with the side wall, and is discharged through 3 steel penstocks which conduct it down the slope through the power house substructure to horizontal single-runner Francis turbines in scroll cases, located on the tail-race side of the station.

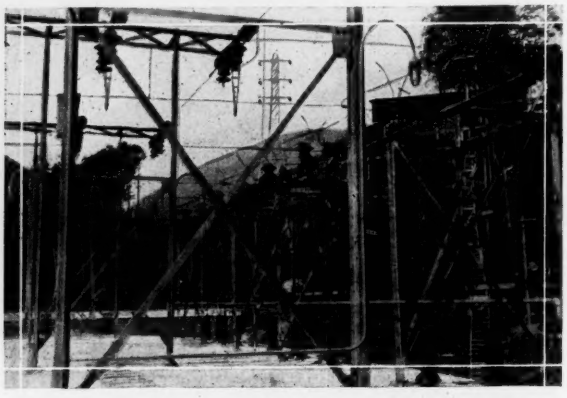


FIG. 5. SWITCHING APPARATUS ON ROOF OF STATION

For operating flexibility and as an additional factor of safety, it was deemed advisable to provide a simple means for shutting off the water, not only at the surge tank, but also at the power house. Because of the excessive cost, due to the large diameter of penstock, relatively high head and exceedingly limited available space in the power house substructure, the use of gate valves 78 in. in diameter proved to be out of the question. Instead, however, the Butterfly or wicket type of shut-off

valve was employed, which, though somewhat cheaper, is of more rugged construction and permits of ready closure against full head and flow of water, a feature of great value in cases of emergency.

Building

This, which has dimensions of approximately 100 by 100 ft., is built of brick around a framework of structural steel upon a substructure consisting of a series of walls placed upon a concrete mat, which in turn rests upon a compact boulder formation. The building proper consists of water wheel, generator and transformer sections, the latter being 2 stories in height. All floors and roof are of reinforced concrete, the latter being covered with a 5-ply tar and gravel roofing.

Because the building and some of the foundation had been built some time before the hydraulic equipment was installed, the general arrangement of this machinery, penstocks and outlets was practically fixed by existing conditions. The capacity and speed of the turbines had to be made in accordance with the converter sets, already installed, hence it was necessary to design all other apparatus to conform closely to these existing conditions, and a special study was necessary for the purpose of determining the most efficient and reliable apparatus and of placing this in such a manner as to allow for convenient operation and accessibility.

Three 7000-hp. Allis-Chalmers turbines of the horizontal-shaft, self-contained, single-discharge, spiral-case type, operating under 226 to 240 ft. effective head at 300 r.p.m. are installed. The center line of the shafts of these machines was fixed by those of the installed sets to which direct connection was made by means of a forged flange coupling with a filler plate.

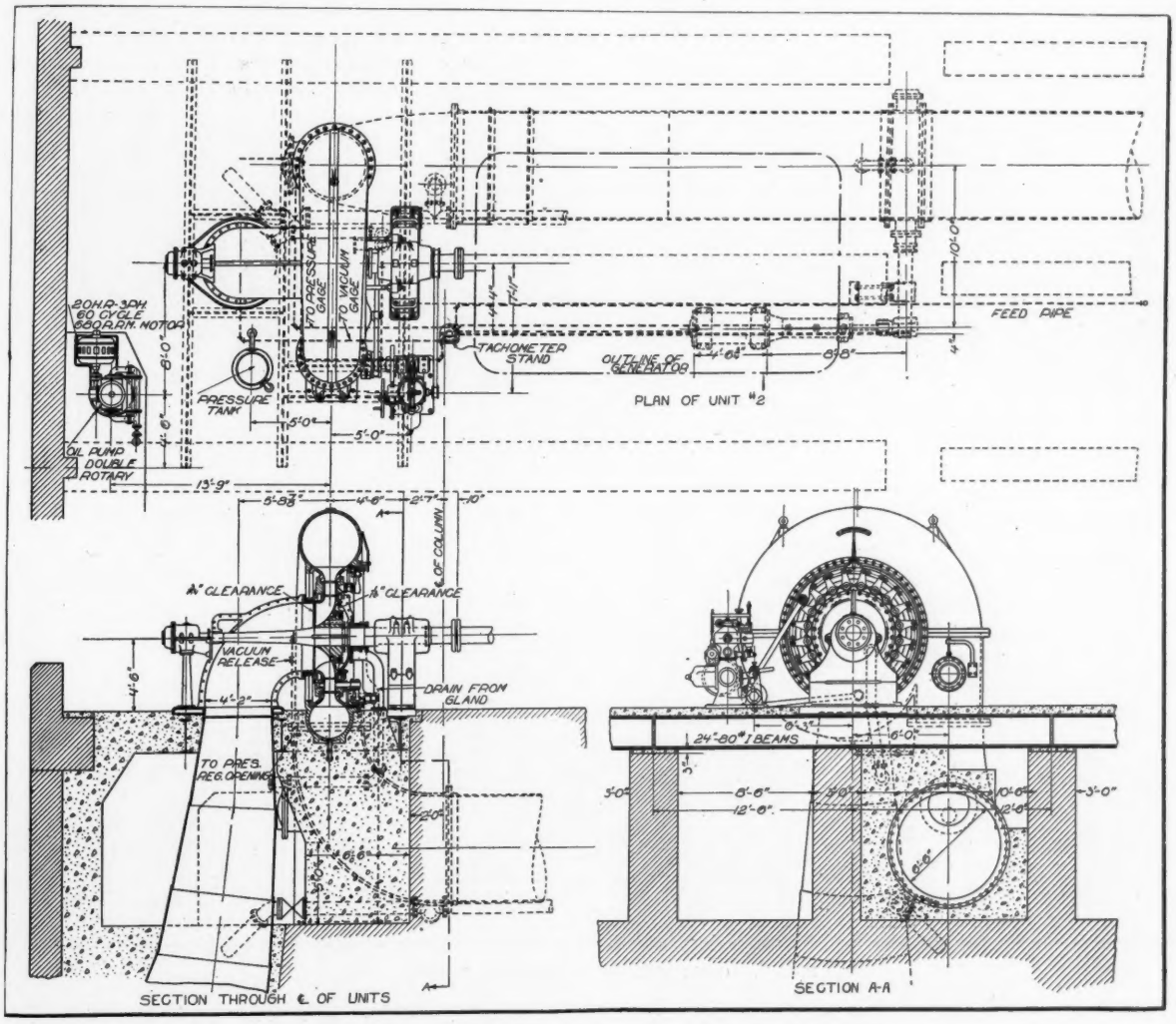


FIG. 4. PLAN, ELEVATION AND SECTIONAL VIEW OF TURBINES

The vertical bottom inlet of the cast-iron spiral casing connects to a quarter turn, the horizontal center-line of which was also fixed by the existing penstock. In a like manner, it was necessary to lay out the steel-plate draft tube bend so as to require no additional excavation.

The bronze runner, designed to be removed toward the draft tube side of the turbine, is bolted to a cast-steel hub keyed upon the turbine shaft. Two substantial ring-oiling bearings, one of the generator pedestal type, the other of the cantilever type, are used, the

latter carrying a double-acting mechanical thrust bearing of the Allis-Chalmers Manufacturing Co. type, which, however, is in action only at the time of starting and stopping. Under normal conditions, the runner and other revolving parts are hydraulically and automatically balanced by a device patented and controlled by the manufacturer of the turbines.

The spiral casing is split horizontally for facilitating erection, and is held together at its inner periphery by a cast-steel speed ring with a series of cross-webs placed so as to offer least obstruction to the flow of the water into the guide case.

In order to obtain high efficiencies, even at part gate openings, and to permit correct regulation by the governor, the wicket-gate type of guide vanes was employed and all connections, such as levers, links, shifting ring, etc., are placed outside where they are readily lubricated and accessible.

All surfaces exposed to the flow of water at high velocities are lined with removable steel plates to facilitate repair work.

The governors used in connection with these turbines are of the Allis-Chalmers oil-pressure type. Each unit has its own governor, belt-driven from the main shaft and directly connected to the gate shifting ring. The connection between the governor and the turbine gates is as direct and rugged as possible, so as to avoid all lost motion, which might result in rapid wear and tear of the connections and cause incorrect speed regulation. A mechanical hand regulating device enables ready manual control of the turbine.

For normal operation, however, the governors are electrically controlled from the switchboard, allowing the amount of load to be distributed over the 3 units at will and also whereby the speed of the whole system can be raised or lowered as conditions may require. An interesting feature with these governors is found with the load-limiting devices. By means of these, the maximum load carried may be limited to any desired amount and yet the governor is always ready to reduce the gate opening of the turbine, should the speed rise beyond that for which the load limiting device has been set.

Oil pressure for the governors is furnished by a central oil-pressure system consisting of 2 motor-driven direct-connected rotary-gear pumps, each having a capacity of about 50 gal. per min. against a maximum pressure of 250 lb. These pumps, said to represent the best solution of the pump question for such purposes, deliver the oil through a central piping system to the individual pressure tanks, from which it is carried to the governors and then returned again through a central piping system to a central receiver tank.

Another feature of interest is the unloading valves employed with this system. Since the units serve to furnish current for the electrical operation of the trains through the Hoosac Tunnel, the governors are at times called upon to regulate severe load fluctuations, and an oil pressure supply of ample capacity had to be pro-

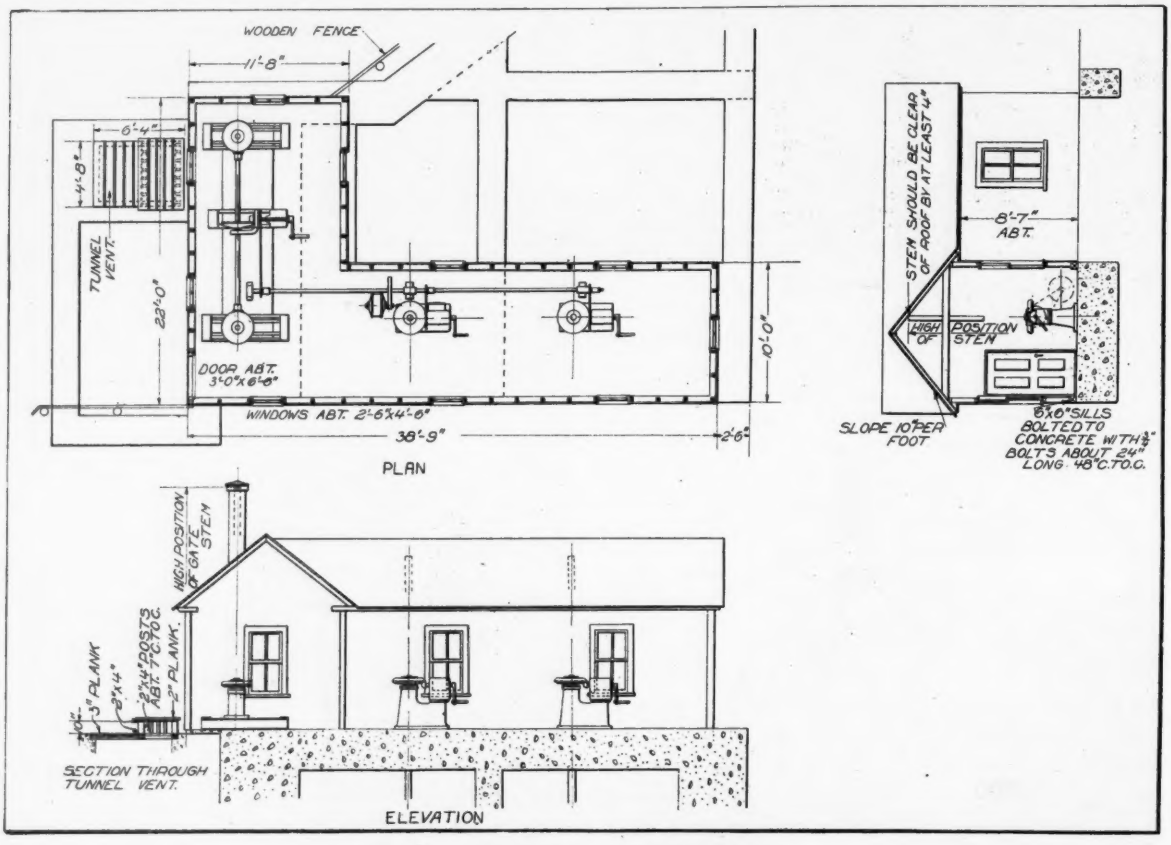


FIG. 6. GATE HOUSE AT MONROE BRIDGE

vided to take care of the large displacement of oil by the governors, which at times of relative quiet, when no trains are starting or stopping, would be wasted. At such periods these patented unloading valves, bypassing the oil and allowing it to return from the pumps directly to the receivers under practically no overpressure, permit a saving of considerable power otherwise wasted. As soon as the oil pressure drops below a certain minimum in the pressure tanks, the unloading valves close the bypasses and the pumps deliver oil under pressure into the tanks again.

Generating Equipment

Each turbine is direct-connected to a double generating set consisting of one machine rated at 4250 kv.a., 2300 v., 3-phase, 60 cycles at 80 per cent power factor and another rated at 4300 kv.a., 11,000 v., single-phase, 25 cycles, at a power factor of 70 per cent. These sets are provided with field excitation from 3 compound-wound exciters, each rated at 150 kw., 125 v., and driven by 225-hp., 2300-v., induction motors. One exciter is arranged for the excitation of the 2300-v., generator, one for the 11,000-v., generator, while the third may be used for either machine. Tirrill voltage regulators mounted on the switchboard are used in connection with these exciters.

The transformer equipment consists of 3 3000-kv.a., 66,000/2300-v., 60-cycle, 3-phase and 3 1500-kv.a., 33,000/2300-v., 25-cycle, single-phase oil-insulated water-cooled transformers of the General Electric make and 3 1250-kv.a., 22,000/2300-v., 60-cycle, single-phase, oil-insulated, watercooled units, manufactured by the Westinghouse Co. No transformers are used with the 11,000-v. machines as this service is fed directly to the transmission lines supplying the Hoosac Tunnel with current.

All of the low-tension switching equipment which is of the solenoid type, electrically controlled from the

FIG. 8. SECTION OF CONDUIT DURING COURSE OF CONSTRUCTION

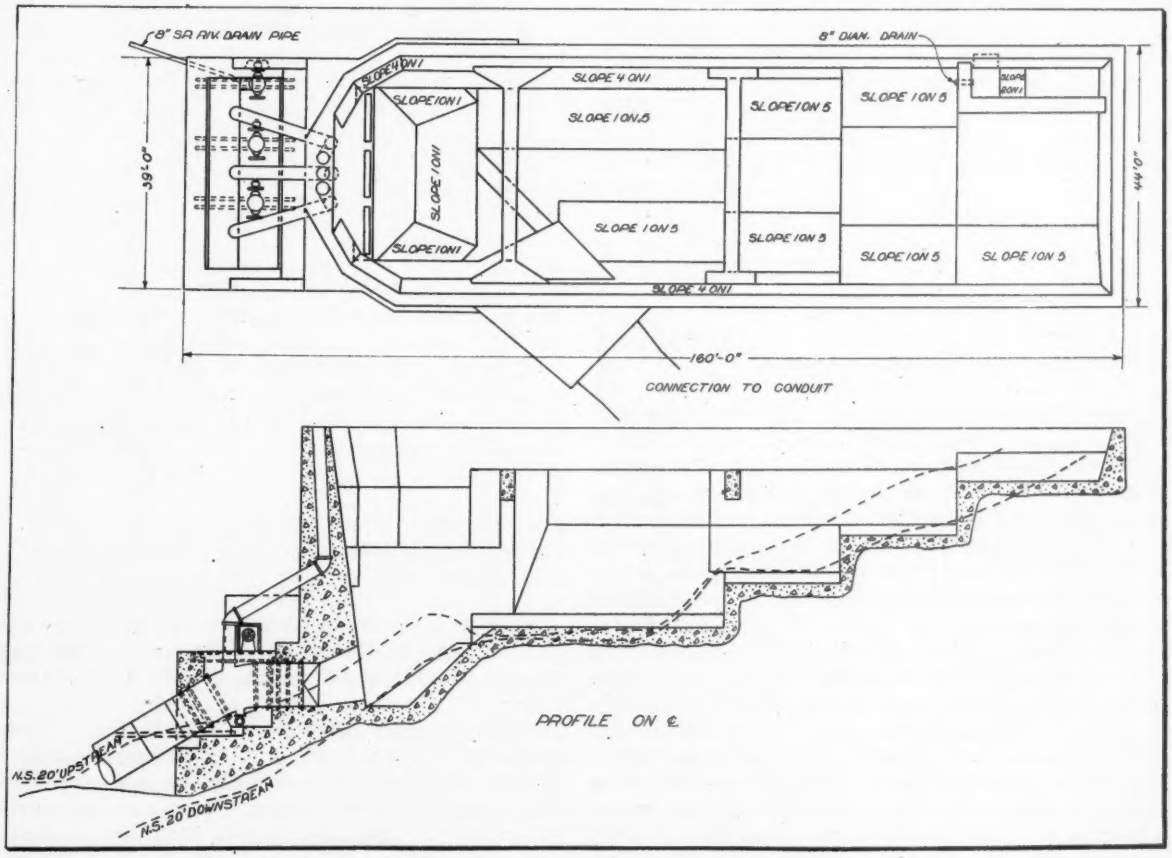


FIG. 9. PLAN AND SECTION OF SURGE TANK

switchboard, is installed in separate concrete bus structures, protected by asbestos barriers and concrete walls so as to render it impossible for anyone to come in contact with live parts of any switch or wire. Duplicate busses are provided with selector disconnecting switches so that any oil switch may be connected to either bus.

All high-tension busses and G. E. type K 10 electrically operated switches are installed in a separate room above.

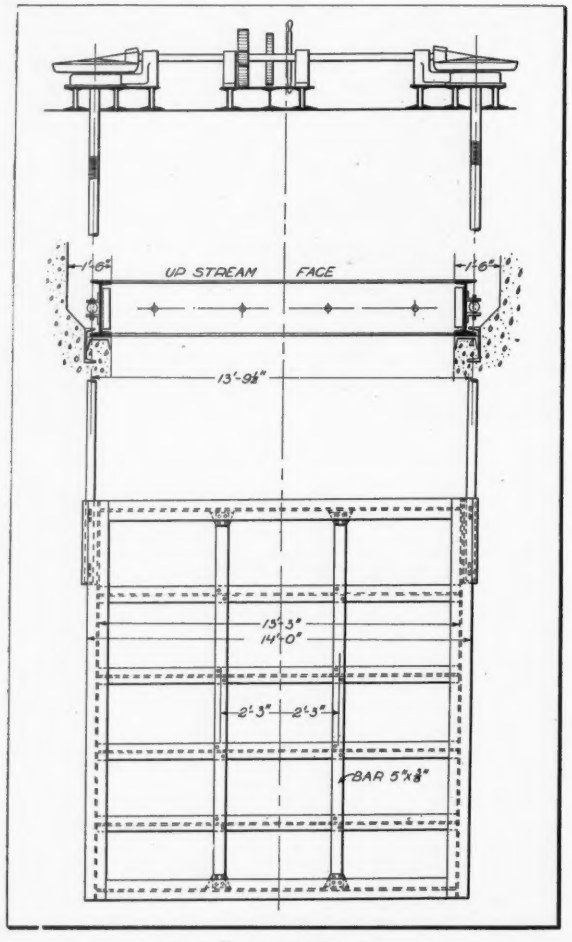


FIG. 7. GATE DETAILS

The high-tension transmission lines enter the station through the roof as shown in Fig. 5, where are also the disconnect switches provided to allow the paralleling of any set of transmission lines, the general wiring being so arranged that energy can be fed from Station 4 over the roof and on to any other station without entering Station 5.

This plant completes one more of the developments on the Deerfield River in southern Vermont, and western Massachusetts, being constructed under the general supervision of Chace & Harriman, Inc., of Boston, with Baker, Ryling & Co., of Boston acting as Fiscal Agents. As with the other Deerfield plants the Power Construction Co., of Shelburne Falls, Mass., handled all the engineering and construction work under the immediate direction of G. W. Bunnell, president, with A. A. Conger, hydraulic engineer, and A. E. Pape, electrical engineer, in charge of the engineering features.

Steam Flow Through Pipe

STEAM PIPE CALCULATIONS MADE EASY BY MEANS OF CHARTS. BY JOHN A. ROSS, JR.

THE weight of steam that will flow through a pipe in a given time varies with the drop in pressure from entrance to exit, the density of the steam, and the diameter and length of pipe. The rational and most commonly accepted formula is:

$$W = K\sqrt{\frac{f\,g\,d^5}{L\left(1+\frac{3.6}{d}\right)}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

W = weight of steam flowing in lb. per minute.
f = fall in pressure from entrance to exit in lb. per sq. in.
g = mean density of steam in lb. per cu. ft.
d = diameter of pipe in inches.
L = length of pipe in feet.
K = a coefficient, given by Carpenter and Unwin as 87.5 and by Babcock as 87.

In this work 87.25 will be used.

While equation (1) is rational in form, it should be noted that our experimental data is limited to small pipes with moderate drop and therefore the results obtained from the curves for large pipes are somewhat doubtful.

If it is desired to find the weight of steam flowing, the other conditions being given, this formula is no more difficult of solution than any equation involving 5 variables, except the tables of square root and fifth powers are almost a necessity; but if the unknown term be the diameter, as is more often the case, the problem becomes more difficult, owing to the presence of the diameter in both numerator and denominator under the radical, and it is necessary to solve by assuming a trial value for d, and solving the equation for W. If the value of W thus obtained does not agree with the given value, we must repeat the process until a satisfactory result is obtained. In order to avoid this cumbersome process numerous tables and some charts have been constructed, but the number of variables involved is so great that most of the attempted solutions cover only a limited range of conditions, and even with their help considerable calculation is involved, and a table or diagram which has to be amended to fit the problem is always a source of annoyance. The set of curves shown in the Reference Tables of this issue is the result of an attempt to devise a method which would enable the engineer to solve any probable steam pipe problem in a minute's time.

EXPLANATION OF DIAGRAM

THE DIAGRAMS are based on equation (1) given above. Charts I, II and III are for small, medium, and large pipes, respectively; Charts IV and IV-A for exhaust steam.

It is customary to designate pipes by their nominal inside diameter up to 12 in. (by some companies up to 15 in.), and above 12 in. to designate them by the outside diameter. In the larger sizes especially, varying thicknesses are used according to the purpose in view, and any additional thickness is added on the inside of the pipe in order to keep the outside diameter constant and the screw threads and flanges standard.

Thus an 18-in. pipe may have an inside diameter of from 16½ to 17½ in. For these reasons it has seemed best to let the pipe diameters, marked on Charts I to VII, inclusive, denote the standard nominal diameter up to 12 in. Above 12 in. the figures on the curves denote the actual inside diameters. Thus the 5-in. curve denotes a pipe with an actual inside diameter of 5.045 in., and the 15-in. curve a pipe with an actual inside diameter of 15 in.

TABLE OF STANDARD PIPE SIZES

Nominal Dia.	Actual Inside Dia.	Nominal Dia.	Actual Inside Dia.
1	1.048	5	5.045
1¼	1.380	6	6.065
1½	1.610	7	7.023
2	2.067	8	7.981
2½	2.468	9	8.937
3	3.067	10	10.018
3½	3.548	11	11.000
4	4.026	12	12.000
4½	4.508		

Example 1. How many pounds of steam per hour will flow through a 6-in. pipe, 400 ft. long, if the entrance pressure is 151 lb. per sq. in. absolute, and the exit pressure 149 lb. per sq. in. absolute?

The drop in pressure is evidently 151 — 149 = 2 lb., and the mean pressure is 150 lb. Follow the 150-lb. pressure line up to the 6-in. diameter line (ab, Chart II), then across to the 2-lb. drop line (bc), then up to the 400-ft. length line (cd), then across to the weight scale (de), and read the answer, 15,500 lb. per hr.

Example 2. It is required to design a pipe to carry 15,500 lb. of dry saturated steam 400 ft. at an initial pressure of 151 lb., and with a drop of 2 lb. This is Example 1 reversed, and the path followed on the diagram should now be e d c b, stopping the line c b where it intersects the 150-lb. pressure line, and reading the diameter, in this case, 6 in.

Example 3. What drop will be necessary in order to pass 15,500 lb. per hr. of dry saturated steam through a 6-in. pipe 400 ft. long, the mean pressure being 150 lb. per sq. in. absolute?

Follow the 15,500-lb. line over to the 400-ft. length line (ed), then drew the vertical line d f of indefinite length. Now follow up the 150-lb. pressure line to the 6-in. diameter line (a b), then draw the horizontal line b g. The intersection of d f and b g will give the necessary drop, in this case, 2 lb.

Note:—The curves were calculated in the following order: Pressure, diameter, drop, length, weight, and in solving problems the path must be traced in the same order, or in exactly the reverse order.

Charts I, II, III, IV, IV-A, are the same except that Charts IV and IV-A have a pressure scale both in pounds per square inch absolute, and in inches of vacuum.

Wet Steam

For wet steam we must use in the diagram, instead of the given pressure, an equivalent pressure, which shall be the pressure of dry steam which would have the same density as the wet steam at the given pressure.

Let P_e = equivalent pressure, P_g = given pressure.
G_e = equivalent density, G_g = given density.
X = percentage of dryness.

Since the density varies closely as the absolute pressure, and since the volume of the water present is negligible, we have approximately,

$$\frac{P_e}{P_g} = \frac{G_e}{G_g} = \frac{1}{X}. \quad \text{Therefore, } P_e = \frac{P_g}{X} \qquad (2)$$

Example 4. How many pounds of steam 90 per cent dry at a mean pressure of 135 lb. per sq. in. absolute will flow through a 6-in. pipe 400 ft. long with a 2-lb. drop in pressure?

$$P_e = \frac{P_g}{X} = \frac{135}{0.90} = 150$$

Therefore use 150 lb. per sq. in. instead of 135 lb., and follow the path a b c d e as in Example 1. Chart V may be used for making this conversion.

Superheated Steam

Here again in the diagrams we use the equivalent pressure at which dry steam would have the same density as the superheated steam at the given pressure. This equivalent pressure may be obtained from Chart VI.

Example 5. How many pounds of steam per hour at a mean pressure of 226 lb. per sq. in. absolute and 300 deg. superheat, will flow through a 6-in. pipe 400 ft. long with a 2-lb. drop in pressure?

From Chart VI we find that steam at 226 lb. and 300 deg. superheat is equivalent to dry saturated steam at 150 lb. per sq. in. Therefore, use 150 lb. in Chart II, and follow the path a b c d e as before.

The curves in Chart VI are so nearly straight lines that they may be used for low pressure steam by simply changing the decimal points.

Example 6. Given steam at 15 lb. per sq. in. absolute and 300 deg. superheat, find the equivalent pressure of saturated steam to use in the diagram.

In Chart V use 150 lb. instead of 15 lb. and obtain an answer of 101 lb.; but the decimal point in our answer must also be changed, making it 10.1 lb.

Valves and Bends

It is customary to consider each valve or bend equivalent to a certain increase in the length of pipe. We have no sufficient data to go by in this case, but Chart VII, based on Brigg's formula, may be used as a rough approximation. A gate valve will offer practically no resistance.

Example 7. Form Chart VII it is seen that a 15-in. globe valve is equivalent to adding 120 ft. to the length of the pipe.

November 29 to Dec. 4 will be a national jubilee of the electrical industry in celebration of the achievements of the Goddess Electra in the industries and arts. Illustrations of the effective value of lighting in sales campaigns; demonstrations of the economy and convenience of electrical devices in the house; selling campaigns for electric light, power and apparatus; concerted effort to emphasize the desirability of electrical devices for holiday presents, are some of the methods to bring publicity and profit to the electrical industry and education to the people.

Efficient Operation of Boiler Rooms

Overloading of Boilers and Chain Grate Stokers Play Important Part in Economy of Steel Plant

BURNING bituminous coal under power boilers without smoke is a problem met in modern cities which seems at times to defy solution by the operators. Since the advent of the gas engine as a user of waste blast furnace gas, the smoke made in modern steel mills comes from their boiler plants. The load on these plants is variable, which also complicates the difficulty of smokeless combustion. That a strict smoke ordinance can be met, at the same time securing a high rate of evaporation under the conditions stated above, has been proved in the plant, the equipment and operating routine of which are described below.

In this boiler room are 8 600-hp. Stirling boilers, arranged two in a setting, all in one row. Under ordinary operation, these boilers are worked at 65 per cent overload, all boilers being kept in operation, except when out for cleaning, and all are served with Playford chain grate stokers, with a grate surface of 11 by 11 ft.

The boilers are suspended from I beams and incased in a brick setting with cast-iron front, and the standard method of baffling Stirling boilers for bituminous coal, giving 3 passes to the gases, is employed. The furnace lining, arches, baffles and bridge walls are all of firebrick. A water column with high and low water alarm features is connected to the end of the front drum, while the feed water discharge to the boiler is regulated by means of a Murray feed water regulator. The feed water enters through the top of the back drum and ends in a T fitting which discharges the water toward both ends of the drum, thus distributing it so that all tubes get water of the same temperature. The omission of fusible plugs in these boilers is a feature not to be recommended, but the laws in this location do not demand them. To insure that the steam leaving the boiler is dry, a perforated dry pipe is located in the steam drum of each boiler.

Two blowoff connections are made to the bottom drum of each boiler and in each connection is a Cadman blowoff valve with an auxiliary gate valve next the boiler. These blowoff connections are used 6 times a day and the blowoff to the water column is opened an equal number of times. Such frequent use of the blowoff with this type of boiler seems entirely too much, as once or at most twice a day should discharge all the sediment that can be removed in this way and the loss due to blowing down so frequently will amount to considerable.

On each boiler are 2 4-in. pop safety valves, connected directly to the center drum. These are tested once each day to be sure they are in good operating condition. On the steam lead to the header is a non-return safety stop valve next the boiler, and a gate valve at the header, an arrangement to be recommended in all plants where 2 or more boilers are employed.

Smokeless combustion is largely dependent upon furnace dimensions in this plant. The distance from the grate to the hanging arch is 2 ft., and from the grate to the heating surface averages about 8 ft. The ashpit is 12 ft. wide, and the distance from the floor to the upper surface of the grate is 3¼ ft. A double coking hanging arch is supported from I beams, and extends over the front part of the furnace.

Bituminous coal with a heat value of about 13,000 B.t.u. is used. This is high in volatile matter, also in ash. The furnaces, however, are operated to secure smokeless combustion, the results being greatly influenced, no doubt, by the coking arch over the front part of the chain grate. The travel of the grate is regulated at about 6 ft. an hour, and the depth of the fuel varies from 6 to 7 in., according to the load upon the boilers. Before the coal is delivered to the hoppers of the stokers, it is thoroughly wet down, which prevents a great deal of the smaller particles of coal from falling through the grate, and, it is reported, does away with trouble from clinkers. The stoker is run with short quick strokes and the fire extends clear to the water back. Records show that 8 lb. of water are evaporated per pound of coal as fired under normal operating conditions, these records, however, are of feed water to the boiler and coal consumed, and no allowance is made for water wasted through blowoff pipes.

Each boiler is served by its own stack which is 160 ft. high and 60 in. in diameter of unlined steel. The draft secured from this stack is about 1 in. on the boiler side of the damper and over the fire averages about 0.2 in. Draft is controlled by means of a hand operated damper in the stack.

Coal is weighed as it is delivered to the plant and the daily consumption is estimated.

It is brought by means of a hoist from a barge in the river to the bucket conveyor in the plant which delivers it to bunkers over the front of the boiler room. These bunkers discharge through chutes to the hoppers of the stokers.

A cast-iron pan under the front part of each grate catches the unburned coal and coke which is shoveled back into the hopper of the stoker. The ashes and clinkers are discharged over the end of the grate into a pit below the furnace which has an inclined bottom leading to a bucket conveyor. The conveyor elevates the ash to a hopper which has a capacity of 1 car, and this discharges into a railway car on a track just outside the boiler room.

Water is measured as it is delivered from the heater to the boiler by means of a Venturi water meter. There are no steam flow meters in the plant, which is unfortunate as the loss due to frequent blowing down would then be shown. The temperature of the feed water as it enters the boiler is recorded by means of a Bristol recording thermometer and averages about 210 deg. The flue gas temperature is taken occasionally and varies from 400 to 550 deg.; the variation is reported to be due largely to the variable load conditions. Gas analyses are taken only occasionally and the percentage of CO_2 is reported as high, but no record is kept of this percentage, and the men in charge were not certain as to the exact figures. This method should be revised so as to keep

the firemen posted as to the proper condition of the fire.

Water used in the boiler is treated with sodium fluoride, which, it is reported, gives excellent results. One boiler is out of service all the time, for cleaning and repairs, so that each boiler is given a thorough overhauling once in 4 or 5 months, when the tubes are turbined. The boilers are washed every 2 weeks, using hydraulic pressure in a hose at 450 lb. At the same time the boiler is cleaned externally and before being put on the line after any cleaning has been done, the boiler is tested to a pressure of 150 lb. hydraulic pressure. The boilers are worked at a pressure from 120 to 150 lb., depending upon the service which they are to perform.

Soot is blown from the boiler tubes by means of an air pipe thrust through openings in the settings once each week. Here is another place where a change in program would undoubtedly result in better economy. While the flue gas temperatures are reported to vary from 400 to 550 deg. as a result of a varying load, it is quite probable that if an investigation were made, this variation would be found to be due to the amount of soot and scale on the tubes. Soot is one of the most effective insulators of heat and should be kept off the tubes as far as possible. With the means available here and the class of coal used, blowing the tubes once a day should prove profitable and where more convenient blowers are installed, their use at more frequent intervals is frequently advisable. Too little attention is paid to flue gas temperature in the average plant for much can be learned from its variations as to the condition of tubes and in some plants the frequency of blowing tubes and cleaning them of scale is governed by the rise in temperature of the flue gas.

The boiler settings are carefully watched to see that air leaks do not form, and a torch is frequently used when going over the settings to determine the location of leaks. Fire clay is used for stopping up holes, and for examining baffles a lamp is held on one side, while the observer is on the opposite in the dark portion of the boiler.

This plant lacks some instruments and equipment which would put it on a more economical basis but above all, the engineer should do a little investigating and he would undoubtedly change his program somewhat.

Novel Condensing System at Connors Creek Plant

SURFACE CONDENSERS FOR MAIN UNITS; BAROMETRIC CONDENSER FOR AUXILIARIES. HUGE COMBUSTION CHAMBER, HIGH OVERLOAD BOILER CAPACITY; HIGH STEAM VELOCITIES; DISTILLED MAKE-UP WATER; RECOVERY OF RADIATED HEAT ARE FEATURES OF PLANT. BY C. F. HIRSHFELD

SINCE the time the results of tests were reported on the boilers in the Delray plant of the Detroit Edison Co. the work of the engineers in charge of this remarkably successful plant has been constantly watched by those interested in power plant work. The description of the latest important development by this company, known as the Connors Creek Plant, which was presented before the American Society of Mechanical Engineers by C. F. Hirshfeld made public a number of important innovations in power plant design and construction. Following is an abstract of this paper bringing out the most noteworthy features.

The main units are rated at 25,000 kv.a. or 20,000 kw. at 80 per cent power factor. The steam end consists of a horizontal, 9-stage, 1200 r.p.m. turbine; the electrical end generates 3-phase, 60-cycle current at 4800 volts. A section of the turbo-generator unit is shown in Fig. 1. The steam exhausted from the turbine passes down through a large expanding exhaust nozzle into the condenser. Each condenser is built to contain 35,000 sq. ft. of heating surface made up of 1-in. tubes a little over 18 ft. long, but has only 32,500 sq. ft. installed. The tube heads have a diameter of 14 ft. 6 in.

The tubes are so arranged as to leave numerous lanes through the steam space, so that the vapor and air readily flow to all parts of the cooling surface. No baffles of any kind are used, excepting only those necessary to form an air box. The latter is located at the bottom of the condenser, as indicated in Fig. 2.

The condensate collects in a cylindrical hot-well which extends from the lower part of the condenser shell, and it is removed by either one of 2 hot-well pumps. These are motor-driven 2-stage centrifugal pumps operated at 1200 r.p.m. and they are fitted with bronze impellers. The condensate is discharged into what is known as the cold end of the boiler feed tank, as will be explained later.

Circulating water is supplied to each condenser by a motor-driven single-impeller double-suction, volute pump. The motor is 3-phase, slip-ring type arranged for a 15 per cent speed variation, the maximum speed being 400 r.p.m. During the period of the year when the circulating water has a high temperature, the pump will be operated at the highest speed and will deliver about 40,000 gal. per min. When the water temperature is low, the pump will be operated at the lower speed and the quantity will be proportionately reduced. The temperature of circulating water varies with the season from 34 deg. to 76 deg. F.

The circulating water enters the property through an open cut and thence flows through a concrete tunnel to the screen house. This tunnel has a free section 9 ft. 3 in. high by 10 ft. wide, and when it is supplying water for all of the units in the finished plant under the lowest water conditions on record, the water velocity will be just under 8 ft. per sec.; in obtaining this, further units are assumed to be larger than those now installed.

The water flows from this section of the tunnel into a sort of funnel-shaped enlargement which leads it to the screens. These are of the traveling variety and are similar to screens already installed in the Northwest Station in Chicago and at the Delray Station in Detroit. They consist of woven-wire panels fastened to the links of an endless chain, the lower end of the loop thus formed projecting down to the bottom of the water channel.

When a screen becomes fouled, the working side of the loop is drawn up and over the upper guide shaft, its place being taken by what was previously the back side of the loop. This operation brings the fouled screen panels under a wash pipe which washes the fouling material into a channel arranged to carry it to the overflow canal. The screens are operated by motors and are started and stopped periodically as required. Their constant movement is only necessary under exceptional conditions. Provision is made for returning water from the overflow tunnel into the intake to assist in keeping screens and tunnel clear of ice during cold weather.

After passing through the screens, the circulation water is turned through a right angle and flows down the length of the house in a tunnel which is 51 ft. wide and 9 ft. 3 in. high. Water is picked up by the circulating pumps through large angle fittings encased in the side wall of this tunnel.

The water passes in the condenser are rather unusual. The entering water flows through the tubes occupying one vertical half of the condenser plus those enclosed by the air box, or cooler, at the lower end of the other vertical half. The water then returns through the tubes above the air cooler and overflows through a large cast-iron nozzle and elbow which points down stream in the overflow canal.

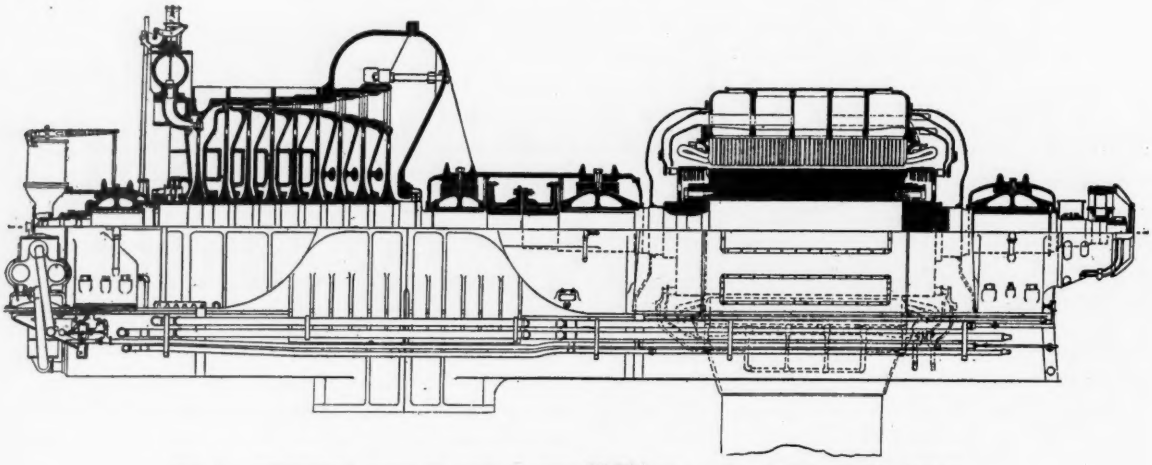


FIG. 1. SECTIONAL VIEW OF ONE OF THE 25,000-KV.A. TURBO-GENERATOR UNITS

Air and non-condensible vapors are removed from a header space in the cooler by means of a 35 by 39-in. rotative, dry vacuum pump. This pump is arranged for 2-stage operation in one cylinder, one end of the cylinder serving practically to load the other. A direct-current motor with armature mounted on the crank shaft drives the unit. The normal speed of the pump is 100 r.p.m., but the motor is arranged for a speed reduction of 40 r.p.m. and need seldom be operated at or near its maximum.

It will have been observed that all of the auxiliaries thus far mentioned are motor driven. As a matter of fact, this is true of all the auxiliaries in the plant with the exception of the boiler feed pumps. The latter are 1200 gal. per min. 4-stage, double-suction, centrifugal pumps, driven by 350-hp. steam turbines, at 2000 r.p.m.

The motor-driven auxiliaries may be operated, all or any of them, with power taken from the system bus, or with power taken from turbine driven, 1000-kw. alternators, known as house service alternators. In every case, that arrangement is used which, in conjunction with the other adjustments will give the best heat balance for the station, under the conditions at the time existing.

What may be called the house service system is shown diagrammatically in Fig. 3. It is really a development of a method long used in both marine and stationary practice, in which a feed water heater is operated under vacuum. In the present instance, the wet vacuum pump of each main turbine unit discharges into one end of a large tank, known as the boiler feed tank. A centrifugal pump draws its water from the same end of this tank and discharges it into the head of a barometric condenser, as shown in Fig. 3. The relatively cold condensate is picked up by the second pump before it has time to mix with the mass of water in the tank, and serves as injection water for the barometric condenser. The house-service alternator turbine and the boiler feed pump turbine exhaust into this barometric condenser, so that the condensate from the main unit takes up all the heat of the auxiliary steam. The foot of the barometric condenser is immersed in the other (or hot) end of the boiler feed tank. The mixture is there picked up by the boiler feed pump and delivered to the boilers.

The barometric condenser is therefore the equivalent of an open feed water heater in which exhaust steam from the auxiliaries mixes with and heats the condensate from the main units, the mixture passing to the boilers as feed water. This condenser, however, offers possibilities not possessed by the ordinary open heater in that it is capable of maintaining a very low back pressure, if this is desired, or can be operated at any pressure between this and atmospheric. This property, taken in conjunction with the great variation of the auxiliary turbine water-rate with variations of back pressure, gives great flexibility of control of the station heat balance.

This is shown diagrammatically in the upper left hand corner of Fig. 3. The straight lines represent total steam consumption of the house alternator turbines for the entire range of load at different back pressures. Assume that at some particular time with a given load

and vacuum on the main unit, the load on the house alternator has the value indicated by the vertical lines, and that the back pressure is that corresponding to the middle steam consumption line as at *a*. If the feed water temperature is too high it can be lowered by decreasing the back pressure, reducing the steam consumption to some such value as that shown at *c*. In this way, the feed water temperature can be accurately controlled, just enough auxiliary exhaust being made available to give the desired temperature.

The variation of the back pressure is obtained by means of a back-pressure valve in the exhaust line from the boiler feed pump turbine. If, under given constant conditions, this valve is partly closed down, the back pressure on the boiler feed pump turbine is increased and its steam consumption for the same load is correspondingly raised. This, however, means that more steam enters the barometric condenser, and, with a constant quantity and temperature of circulating water (main condensate), the temperature and pressure in the barometric condenser must rise. This, in turn, means higher back pressure on the house alternator turbine and it delivers more steam, still further raising the temperature.

Under certain conditions, this interchange may result in a cumulative temperature rise, ending only when the pressure in the barometric becomes equal to that of the atmosphere and the auxiliary exhaust blows to waste. To prevent such an occurrence, the flood valve shown in Fig. 3 is provided. This is automatically opened whenever the temperature of the steam entering the barometric condenser exceeds a predetermined value. When it operates it admits comparatively cold water from the storage tanks, adding it to the normal supply of injection water entering the condenser, thus bringing the temperature down very quickly. It then automatically shuts off. Under very poor conditions of adjustment, this valve would continue to open and shut periodically until all of the water in the storage tank and boiler feed tank had been heated to about 212 deg. F., but such a contingency is not probable because this would take a long time and the watch engineer would make necessary re-adjustments before the valve had acted many times.

The house alternator, boiler feed pump, and barometric injection pump are all grouped under the gallery. The natural position for the watch engineer is at the same place, so that continuous observation of this apparatus is readily obtained. An auxiliary gage board containing instruments showing critical temperatures, pressures and quantities is located within easy view, and the results of all adjustments are readily seen.

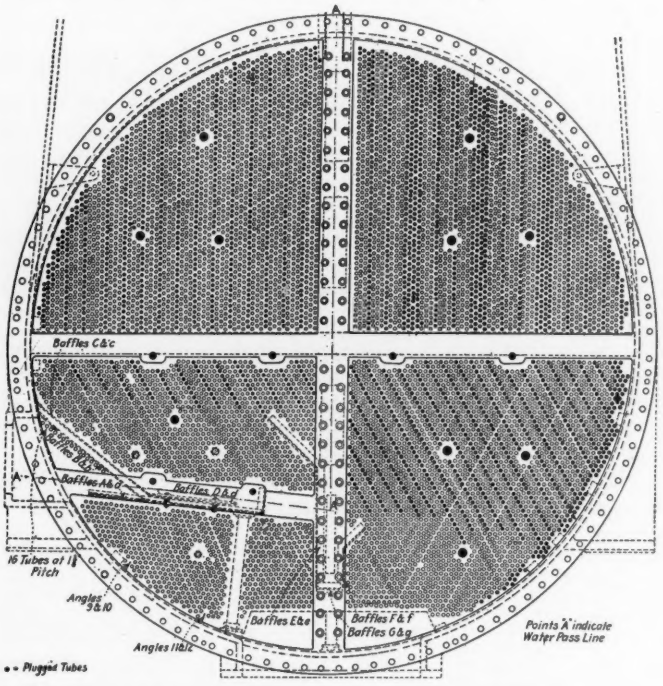


FIG. 2. DETAILS OF TUBE ARRANGEMENTS IN CONDENSERS

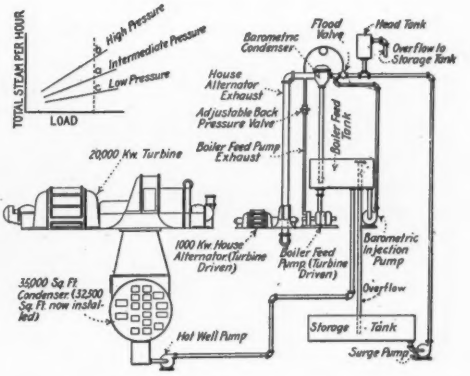


FIG. 3. ARRANGEMENT OF THE HOUSE SERVICE SYSTEM

This method of operating the auxiliaries appears very complicated when described on paper, but it has proved to be very simple in practice, and easy to handle. It possesses the following advantages which should be compared with methods more commonly used:

First: The one great advantage of steam driven auxiliaries is retained because exhaust steam is available for feed water heating;

Second: The quantity of auxiliary exhaust can be fitted to the ability of the feed water to absorb it;

Third: All the advantages of motor drive are obtained;

Fourth: Up to the ability of the feed water to absorb steam, the power used by the motor driven auxiliaries is produced at a thermal cost practically equal to that obtained in the case of steam driven auxiliaries;

Fifth: Since the feed water heater is normally operated under a vacuum, the feed water temperature is readily maintained at a value which will give ideal economizer operation;

Sixth: Because of the vacuum maintained in the feed water heater, air is readily removed from the feed water just before it enters the boiler feed pumps. In practice there is no re-absorption of air by the condensate between main condenser and boilers.

Boiler Dimensions

The boilers are similar to those used in the older plant at Delray, but are set 3 ft. higher so that the height of the combustion chamber is 33 ft. These boilers each have 23,654 sq. ft. of water heating surface and are built to operate at 225 lb. per sq. in. The superheaters have about 2400 ft. of surface and are designed to give 200 deg. F. superheat at 200 per cent of rating.

There are only 2 boilers per turbine. When operating the turbine at full load, the boilers will operate at about 170 per cent of Centennial rating. In the ordinary sense, there are no spare boilers. Experience has shown, however, that these boilers can be safely and economically operated at ratings considerably in excess of 170 per cent and provision has been made to enable 3 boilers to supply steam to 2 turbine units. When carrying full turbine loading under these conditions, each of the 3 boilers will have to operate at about 225 per cent of rating.

The steam leads from each boiler are of 10-in. pipe and these join together in a Y-fitting, which as a 14-in. discharge. Under full load conditions with 2 boilers supplying one unit, the steam velocities will be about 10,500 ft. per min. in the 10-in. pipe and 12,000 ft. per min. in the 14-in. pipe. With 3 boilers supplying 2 units, these velocities will rise to about 14,000 and 16,000 ft. per min., respectively.

Distilled Feed Water

Another unusual feature is the provision for the distillation of all make-up water. Experience at Delray has shown that the quantity of make-up required is readily held down to 1.5 or 2 per cent. Under such conditions, the apparatus required for distillation is small and the cost is negligible in comparison with the cost of boiler labor saved. The evaporator installed has a capacity of 12,000 lb. of vapor per hour and is heated by high-pressure steam. The vapor formed in it passes directly to the barometric condenser in which it mixes with the auxiliary exhaust and thus becomes part of the feed water.

Many cases of boiler pitting and corrosion which are recorded in engineering literature have been attributed to the use of very pure water and the presence of a small quantity of scale-forming material has, therefore, been regarded as desirable. Most authorities now seem to believe that pure water is not responsible for such damage to good boiler metal, but that the blame is to be laid on small quantities of atmospheric carbon dioxide dissolved in what is assumed to be pure water.

In the Connors Creek plant, the feed water heating and storing system has been so designed as to prevent the absorption of air, so far as prevention is readily possible. Should experience show that the provisions made are inadequate to insure safe boiler operation there are several simple remedies. The simplest is probably the use of a very small quantity of an alkaline salt.

Another innovation in this station is the very complete provision for the recovery of radiation and electrical losses. Air enters the turbine room principally through louvres above an air washer. This air, after being washed if necessary, passes down through the turbine room, picking up part of the heat lost by the steam apparatus. Ultimately it is drawn into the generator, picks up the heat representing the losses therein, and is discharged through a duct below the turbine room floor. This duct carries the heated air into the pipe gallery in which the stoker blowers are located. On its way to the blowers the air passes around the outside of the covering of all steam pipes, so that it also picks up the heat which these surrender to the surrounding atmosphere. In this way a large fraction of these unavoidable losses is conserved by being delivered to the boiler furnace, and just that much less heat need be supplied by fuel.

Humidity and Leather Belts

THAT relative humidity of the atmosphere has a great deal to do with the efficient operation of oak tanned leather belts has long been recognized; but just what results the changes in humidity would have has not, until recently, been determined.

At the Spring Meeting of the A. S. M. E., William M. Bird and Francis W. Roys gave the results of experiments with belting which were carried out to determine:

(a) The effect produced on the center distance by varying the sum of the tensions, the relative humidity remaining constant.

(b) The effect of the relative humidity on the center distance, the sum of the tensions remaining constant.

(c) The effect of the relative humidity on the sum of the tensions, the center distance remaining constant.

The general conclusions arrived at as the result of a series of exhaustive tests are:

First: If a belt be set up at low relative humidity, slipping will probably occur if the relative humidity increases to any great extent, especially if accomplished by a rise in temperature.

Second: If a belt be set up at high relative humidity, excessive pressure on the bearings and stretching of the belt will result from a decided decrease in relative humidity, especially if accompanied by a fall in temperature.

Third: If a belt be set up at a medium relative humidity, the tensions will not be excessive at lower relative humidity, nor will there be any great danger of slipping at high relative humidities unless accompanied by excessive temperature changes; in other words, the factor of safety in the ordinary belt rules is sufficient to take care of the effect of changes in the relative humidity if the set up be made at a medium per cent of relative humidity.

Fourth: If a belt be set up at any relative humidity with a spring or gravity tightener, a load 50 per cent greater than the standard can be transmitted at either high or low humidity without danger of stretching the belt, slipping or excessive pressure on the bearings.

Boiler Feed Water--IV.

INCRUSTING SOLIDS, THE CAUSE OF MOST BOILER TROUBLE. BY F. F. VATER

INCRUSTING solids consist of silica, iron oxide and alumina, lime and magnesia. They are the substances that fill up your feed pipe, coat the valves in your pump, cut-out valves and cocks in your feed lines, scale up the tubes and sheets in your boiler and to a greater extent than any other impurity, eat into your coal pile. They are the substances that compel you to shut down, cool off, clean, turbine, close up, fire up and lose that Sunday which your physical nature requires, irrespective of any religious belief or teachings.

I have met a few men in consultation on plant betterment who have said at the start, "I want this plant in such shape that no Sunday work will be required. I don't work Sunday myself and I shan't ask my men to; lay it out so that whatever needs cleaning can be cleaned on week days."

I could not help but feel greater respect for that man, and I wished there were a whole lot more who were bringing that old-fashioned Golden Rule into everyday life, instead of leaving it on the shelf for use occasionally on Sunday.

Silica is usually present in feed water in small quantity. It is not highly soluble. Iron oxide and alumina are likewise generally present in small quantity, as they are not highly soluble. Silica is hard to remove completely. Distill a water and there are usually traces of silica. It precipitates from a water as a gelatine, and becomes hard only upon drying.

Iron oxide and alumina also precipitate as a gelatine and harden upon drying. In small quantity they act as a coagulant on a filter bed and assist filtration rather than having a detrimental effect. They need no further notice, as they are rarely present in water to a greater extent than 3 grains per gallon and in any ordinary method of water softening are reduced to traces without the use of a chemical; hence, they do not add to the cost of treatment.

Lime as present in water is generally found as the sulphate or bicarbonate, sometimes as the chloride and rarely as nitrate. Sulphate of lime is a combination of calcium oxide and sulphuric acid, and as previously stated, has 2 other names; viz., gypsum, plaster of paris. Alone, it forms a dense hard white scale very difficult to remove, and an excellent insulator against heat. It brings the worst troubles attributable to scale.

It is heavy and does not remain long in circulation. It is stable in so far as boiler temperatures are concerned. Bicarbonate of lime is a combination, 1 part of calcium oxide and 2 parts of carbonic acid. It is soluble only because of the presence of the excess molecule or carbonic acid. Alone, it makes a thick open porous scale except under high overloads and high pressures, when it becomes troublesome to turbine out or to remove from plates.

Its specific gravity or weight is less than lime sulphate and it remains longer in circulation in a boiler. It is very unstable as boiler temperatures quickly drive off the excess molecule of carbonic acid. Mono or simple carbonate, being a combination of calcium oxide and carbonic acid in equal parts, is very stable. The lime of commerce is made by burning mono carbonate of lime to an incandescent heat, thus driving off the carbonic acid. The mono or simple carbonate of lime is practically insoluble in water.

Chloride of lime is composed of calcium and chlorine. It is an unstable salt and under boiler temperature will break up, the released chlorine combining with the water as hydrochloric acid. It is not generally found in waters. It occurs in sections where salt is present and where there is not sufficient soda to absorb all of the chlorine. Forming hydrochloric acid, it is very corrosive.

Lime nitrate is composed of calcium oxide and nitric acid. It is rarely found; is very unstable and cannot be used for boiler feeding, if it exists in greater quantities than a trace, unless the water is chemically treated.

Boiler temperatures will separate the lime from the nitric acid, leaving it free to enter the water. Nitric acid is very corrosive. In one case, there was present in a feed water, 5 grains per gallon of nitrate of lime. In addition, there was plenty of lime and magnesia to form a protective scale over the surfaces of the metal. The boilers were literally chewed up in 6 yr. of operation, and had to go to the junk pile.

Inasmuch as this boiler plant installed cost $7200, the owners paid $1200 a year penalty for using water containing nitrate of lime.

Nitrate of magnesia, I have not found as yet; but the effect would be identical with the effect caused by the nitrate of lime.

Where nitrates of lime or magnesia are contained in a boiler feed water, feeding soda ash will prevent any detrimental effect, as the soda will absorb the nitric acid, leaving the lime or magnesia as a carbonate. The nitric acid will combine with the soda, forming nitrate of soda, which will not break up at any temperatures obtained in a boiler.

Magnesia as found in boiler feed water is generally found in the form of bicarbonate and sulphate. It is more frequently present as the chloride than is lime, and is rarely, if ever, found as the nitrate.

Magnesium compounds are unstable upon the application of heat. At boiler temperatures, the sulphate is broken up into the bases, magnesium and sulphuric acid. Hence, if lime is not present to absorb the sulphuric acid, pitting and corrosion will follow its use.

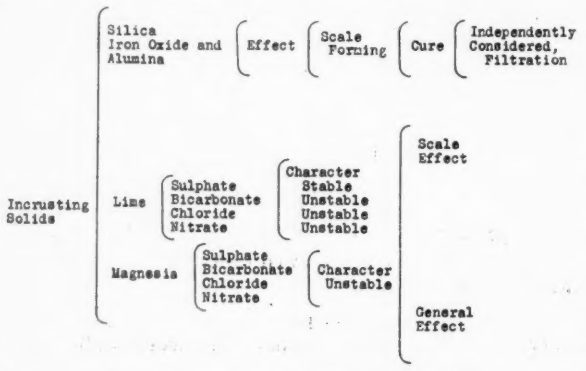
The bicarbonate and mono or simple carbonate are very unstable. Heat applied at a temperature of 160 deg. F. will begin breaking down the combination. That it breaks up at low temperatures is proven by an analysis of the deposit in an open feed water heater, which will show more magnesium has broken up than has the lime.

Another peculiarity of this salt, is that it will be found to have largely precipitated as an oxide. In other words, it has released all of its carbonic acid.

Magnesium chloride is another unstable salt and at boiler temperature will release the chlorine and corrosion will follow. The presence of lime in the water does not help as it does with sulphuric acid, as magnesia has a greater affinity for chlorine than has lime.

Magnesium nitrate will rarely, if ever, be found, as stated above, but it is vicious in its action. A water cursed with its presence should never be used. The effect of silica and iron oxide is to form scale. As just stated, they are rarely present in quantity sufficient to require attention. In such rare cases, however, as they are found, the cure is filtration. This statement considers them alone and not in relation to the lime and magnesia.

That lime and magnesia salts are unstable is the saving feature. If they were stable, it would not be possible to remove them or change their form and the ills they cause would have to be borne. Being unstable, the boiler compound can do its little good and the water softener can effectually cure the trouble they cause.



CONTINUATION OF FEED WATER CHART

All of the incrusting solids increase the density of a water and bring about the troubles density causes. Lime sulphate increases the density the least, because of its great weight and its tendency to settle out of even rapidly circulating water.

Take a water high in lime sulphate, and you will rarely have foaming from density. The magnesium salts increase density because they are light and keep circulating with the water. Recognizing this fact, it will not be necessary to give this quality to them in the chart, as their other characteristics will require quite a little attention.

The effect of the lime and magnesia salts in the formation of scale are somewhat similar; but in order that we do not become confused, we will take up each one separately.

Lime sulphate forms a dense hard impervious scale. It accumulates rapidly and insulates the tubes and plates. Being impervious to water, it causes overheating more seriously than any other incrustant. Being hard, it is the most difficult, and hence expensive to remove. Failure to remove it, will take the life of your boiler. It is not corrosive in its nature when it precipitates in the boiler from the action of heat. It precipitates as lime sulphate.

Lime bicarbonate, under high pressure and overloads, forms a carbonate scale hard enough to require the use of a turbine. Its precipitate is more open than the sulphate, and its action is not as serious. It breaks up under heat into the simple carbonate, releasing carbonic acid, and there may follow some corrosion. The precipitate, unless baked hard, is a fine soft white powder.

Lime chloride breaks up under boiler temperature, and in the presence of water, into hydrochloric acid, and mono (simple) carbonate of lime. It is, therefore, very corrosive. The precipitate being lime carbonate, its action is the same as relates to scale as the bicarbonate.

Lime nitrate breaks up under boiler temperatures, as lime carbonate and nitric acid. Hence, it is very corrosive. The precipitate is mono or simple carbonate of lime, with a resultant scale action.

These are their individual characteristics and effects, but there is an interrelation that we must understand.

If a water contains lime sulphate alone without the bicarbonate being present, as just stated, the scale will be dense, hard and impervious. If, on the other hand, the water contains equal parts of lime sulphate and bicarbonate, the scale will be softened by the admixture of the carbonate. It will not be as dense, not as impervious, and the scale can be more easily removed.

This is on the principle that if you were mixing a neat cement and wanted it hard, you would use cement and sand in the ratio of one and one. Now the greater the proportion of sand you use, the poorer the cement.

It is the same in your scale; just as the carbonate is added to the sulphate, you reduce the hardness of the resulting scale, until if your ratio be as 1 to 10, the scale would not be difficult to handle.

To observe the action of sulphate when there is no carbonate present, examine internally a boiler fed through a live steam purifier. Almost without exception you will find a dense hard white scale. The live steam purifier removes the carbonate only.

Take any plant so equipped, draw a sample of water just as it enters the purifier, and just after it has passed out and have them analyzed.

I have stated that magnesium sulphate is unstable and breaks up under boiler temperatures into magnesium oxide and sulphuric acid. Hence, if there be no carbonate of lime in the water, the corrosion will follow. Where lime bicarbonate is contained in the water, the sulphuric acid being stronger will drive out the carbonic acid and combine with the lime-forming lime sulphate whose character you already know. As waters nearly always contain both substances, not much pitting and corrosion have been caused by this salt. If it exists in a water without lime, you will have trouble.

The bicarbonate of magnesia, as previously stated, breaks up at low temperatures, precipitating largely as magnesium oxide. It is light and flocculent, but forms a hard scale. This is because it is in the oxide form.

Lime, in this form is also a builder of hard scale, but it is not found in water in that form. The chloride and nitrate of magnesia break up in the same way as the lime; the precipitate being the oxide of magnesia, principally with some simple carbonate with it. It is a very light flocculent substance; stays in circulation and has a tendency to accumulate on the surface of the water

in a boiler. Its tendency, therefore, is to cause foaming.

All of these substances help to build up scale, and the larger the percentage of sulphate contained in the water, the harder the scale will be. There is the same interrelation between the sulphates and suspended matter that exists between the sulphates and carbonates. The presence of suspended matter reduces the percentage of your cement or binder, the sulphate.

This is a case where you would not want the suspended matter filtered out. I do not believe it is ever worth while to filter a boiler feed water, unless chemical treatment is given it, too.

A few years ago, a large interurban railway station was having a lot of trouble from foaming. The president of the company told me it was organic matter, and asked me to look the conditions over, and tell him what a filter plant would cost.

I visited the plant; found organic matter in the water but also found there were 13 grains of incrusting matter to the gallon, about 4 of which were sulphate. I found that the foaming took place and carried organic matter over into the turbines. It lodged and baked on the blades until it became necessary to take the case off, and scrape the blades. This had to be done about 3 times a year. Although it would be a saving to get rid of it, I told them to save their money until they could spend enough to get rid of all their trouble. Filtering that water would have saved work on the turbine; but it would have caused an expense in the boiler room, that would have exceeded the turbine trouble 5 to 1.

The solution of the problem was softening first and then filtering, putting something nearer H_2O into the boilers to make steam.

That is the salvation of every one of us. We must make steam out of water and not out of suspended matter, soda, lime and magnesia.

In every city in the country where filtration plants have been put in, they have increased the work of the man cleaning boilers, and increased the coal bill.

(To be continued.)

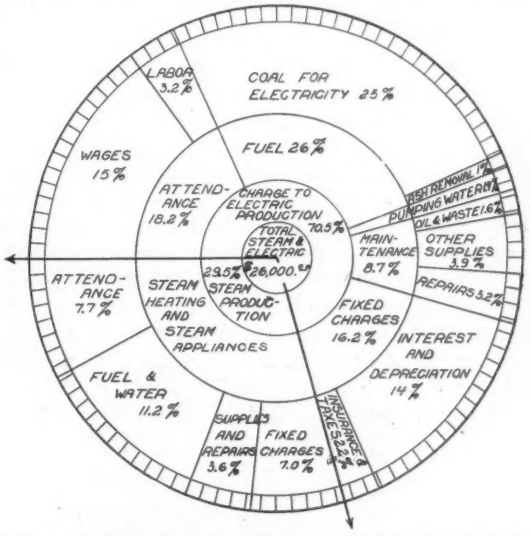
Graphic Analysis of Steam-Electric Power Costs

By J. Wilmore

THE importance of keeping accurate records of power-plant operating conditions and costs is now generally recognized. The systems that have been worked out, however, apply in most cases to conditions in large stations. From the standpoint of efficiency and economy, records of operating data and costs are as essential in small plants as in large plants, and in order to devise proper records, the operating conditions and service requirements of the plant must have careful study. Unless this is the case, the records, though extensive and even elaborate, are often of little value.

The writer has found that the usual figures and diagrams submitted to busy executives have little meaning unless considerable study is devoted to them in calculating and interpreting the data. Usually, tables of figures giving total dollars, or perhaps a tabulation of percentages, are the forms most common; however, such figures do not give at a glance the actual proportion that any one item may bear to the other, for the reason that it is not an easy matter to conceive of relative values.

A graphical presentation of data and costs which represents proportions is, on the other hand, readily understood by almost anyone at first sight. With this fact as a basis, the writer has devised a means of presenting operating costs as in the diagram shown below. Such a diagram gives the actual annual division of charges as found in a small steam-electric plant. The diagram is so divided that all accounts chargeable to steam production are kept independent of those chargeable to the production of electric energy, which is a vital point in analyzing costs in any plant where both steam and electrical energy are used for separate and individual purposes.



DIVISION OF OPERATING COSTS IN A SMALL STEAM PLANT

The plant of the type to which the diagram refers and from which the data shown in the latter were secured is installed in the basement of a light manufacturing building. Inasmuch as the power costs are the only items affecting the operation of the plant, all charges for the steam and electric distribution systems are omitted, as these are chargeable to the building account.

The plant equipment consists of 2 direct-current generating units, one of 75-kw. and the other of 200-kw. rating. These generators are directly connected to noncondensing steam engines, and with 3 coal-burning steam boilers of an aggregate rating of 600 hp., the necessary auxiliaries with piping and wiring complete, represent an investment of about $40,000.

Coal costs $3 per ton at the plant, and water is obtained by pumping it. Exhaust steam is utilized for heating purposes and hot water. The maximum demand is 230 kw., and the average monthly production of electrical energy is 62,700 kw.-hr., representing a load factor of 65 per cent as related to the maximum output of the generator units under steam. The plant employs 7 operators the year around, who compose the engineering and operating staff. Under such conditions the electrical energy is generated for about 2.43 cents per kw.-hr.

The chart shown appeals to the writer as a simple presentation of data and a clear analysis of steam-power-plant costs arranged in such a way as to make comparisons possible at a glance.—Electrical World.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Edison and the Electric Incandescent Lamp

BRIEF OUTLINE OF THE DEVELOPMENT OF THE INCANDESCENT LAMP; DIFFICULTIES ENCOUNTERED IN EARLY DAYS OF POWER STATION OPERATION

EDISON DAY, Oct. 21, commemorates the thirty-sixth anniversary of the invention of the electric incandescent lamp and honors its master inventor, Thomas A. Edison. On Dec. 21, 1879, just 2 months after Mr. Edison first successfully made a carbon filament glow in a glass bulb from which the air had been exhausted, when a current of electricity was passed through the filament, the New York newspapers announced the details of the great invention with startling headlines.

This was even before Edison had successfully determined and chosen carbonized bamboo, the only substance used for about 10 yr. in making filaments for commercial lamps, which was followed by the "squirted" filament employing carbonized cellulose in one form or another, next the metallized carbon filament, then the pressed tungsten filament, and finally the special form of drawn tungsten wire used in modern Edison Mazda lamps. Working down from a consumption of 4 or 5 w. of electrical energy per candlepower in Edison carbon filament lamps to the standard a few years ago of 3.10 w. per candlepower, the Mazda lamp has brought this down in about 5 yr. to about 1 w., while the larger sizes of Mazda gas-filled lamps the reduction in current consumption has reached the low level of nearly ½ w. per candlepower.

FIG. 1. THOMAS A. EDISON AT THE TIME OF THE INVENTION OF THE ELECTRIC INCANDESCENT LAMP

Edison practically began his experiments in electric lighting in September, 1878. Just previous to this he had returned from a visit to a Connecticut factory where an electric arc lamp was used, which concentrated his thoughts on the subject of lighting by electricity, and he determined to tackle the problem.

The task before the young inventor involved commercially: First, the production of a pure, steady and reliable light from electricity; and second, producing it so cheaply that it could compete with gas for general illumination. The electrical problems presented constituted: first, a dynamo of low resistance armature; second, a high resistance lamp, of relatively low candlepower; and third, a distributing system on which the lamps would be connected in multiple instead of in series. All these ideas were revolutionary.

FIG. 2. THE FIRST EDISON INCANDESCENT LAMP

Of the 2 systems before him, the voltaic arc and the incandescence, Edison wisely chose, as we know, the latter as the practical one for the subdivision of electric lighting into little units. The discovery of the proper substance and method for securing the incandescence proved the sticker. The almost boundless scope of his investigations, which is so characteristically epitomized in his remark, "We tried various things," is evidenced in some measure by the patent records. The substances that were experimented with included electric arc light carbon (made into paste and rolled into threads), cotton thread, vulcanized fiber, jute, palm fiber,

grasses, carbonized flax, threads made of lamp black and tar, charcoal, hemp, soft paper, fish line, various combinations of paper and tar, linen, cardboard, celluloid, box wood, cocoanut-hair and shell, shavings from hickory, bay wood, rose wood, and a thousand or more other varieties of wood, lamp wick, punk, cork and bamboo fiber. The practical filament was finally found in the fiber growing just under the outside hard surface of a certain variety of bamboo.

Edison also did a great deal of work with metal filaments, similar to those used at present. Among the early metals experimented with considerably was platinum and alloys. Prominent among the difficulties encountered, it will be remembered, was the liability of platinum to melt under the intense heat of the electric current; and the tendency of carbon gradually to become dissipated under the combined action of gases and the electric current. He tried regulating the current with platinum through levers and diaphragms, but the expansion and contraction of the platinum destroyed the fine adjustment of these devices and they became worthless. Many forms of spirals of platinum and alloys were tried, also osmium-iridium, from which he obtained some success. But Edison found that when metallic conductors that fuse at high temperature are exposed to a high temperature near their melting point in air for several hours by passing a current of electricity through them and then allowed to cool, the metal is found to be ruptured, and under the microscope are revealed myriads of cracks, many of which reach nearly to the center of the wire. He also discovered that they lost weight. These faults lowered their resistance and were fatal to their lasting qualities.

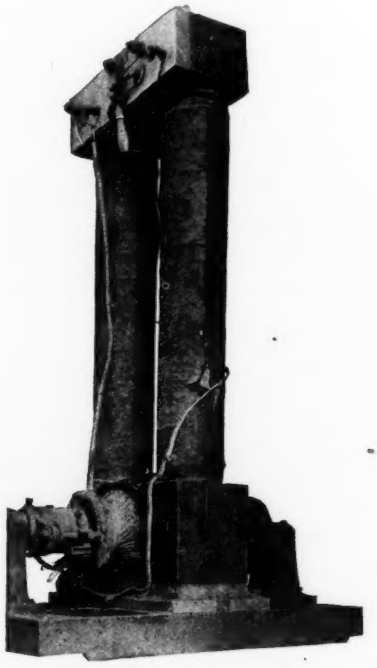


FIG. 3. EARLY EDISON GENERATOR BUILT IN 1883

It seemed then that all the work so far had been futile, but success grew out of failure. This very thing induced him to attempt intercepting the deteriorating effect of atmospheric action, which resulted in the vacuum bulb. Coincident with this discovery it dawned upon him that it was necessary to employ substances with a high ohmic resistance for filaments to improve the quality of the light. And so the first commercial carbon filament lamps were evolved, and later through various stages of research the other improved types up to the present modern Edison Mazda lamps.

The next great problem that Edison tackled was a system of distribution. Prior to 1880, there was no method known by which large numbers of electric lights of a power about equal to a gas burner could be operated practically over large areas. Speaking of this period, Edison said: "I had the central station in mind all the time. I wanted to use 110 volts. Now there is no use for you to ask me why, because I do not know, but somehow that figure stuck in my mind; and I had calculated that if we could get the voltage up that high, the copper cost would be somewhere within sight."

In regard to installing his first central station, the old Pearl Street station in New York City, he said: "You cannot imagine how hard it was. There was nothing that we could buy or that anybody could make for us. There were no high-speed engines, and the manufacturers said they were impossible."

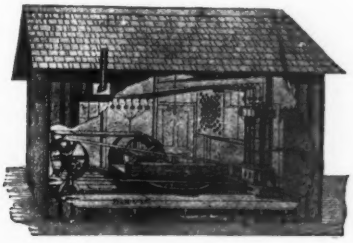


FIG. 4. INTERIOR OF THE FIRST COMMERCIAL EDISON 2-WIRE LIGHTING STATION IN THE UNITED STATES, AT APPLETON, WIS., 1882

Mr. Porter, of the old Porter-Allen Engine Co., built for Edison his first high-speed engine, of 150 hp. and 720 r.p.m. Edison says: "We set the machine up in the old shop, and as we had some idea of what might happen, we tied a chain around the throttle valve and ran it out through a window into the wood shed, where we stood to work it. It ran, O yes, it ran. Every time she turned over, she shook the firmament, and tried to lift the whole hill with her. Toned down to 350 revolutions, she ran satisfactorily, and everybody said, 'Why, how beautifully she runs, and how practical such an engine is.' Now, don't you know I knew they would say that? Didn't you ever find out that trying to do the impossible makes about half the impossible seem easy?"

While this work was going on in the shop, underground mains were being laid in New York. "During this period," says Edison, "I used to sleep nights on piles of pipe in the station." Finally, the great day for trying out the system arrived. "We started one engine and all was well, and we had 500 ohms resistance. Then we started another engine and threw them in parallel.

Of all the circuses since Adam was born, we had the worst then. One engine would stop and the other would run up to about 1000 revolutions. Then they would see-saw. When the circus began, the gang bolted, and kept running for a couple of blocks. What was the matter? Why it was those darn Porter governors." By connecting all the governors together, the engines were finally made to behave.

Once, when a heavy load was unexpectedly thrown on, Edison called up his station and inquired. "How is it at the station?" The reply came back. "Oh, bully. Everything is red-hot, and the ammeter has made 2 revolutions!"

Of switchboard instruments there were none. In his early work, Edison said: "We used to hang up a shingle nail and tie it alongside of a feeder, and that was our heavy current ammeter. It worked all right. When the nail came close to the feeder, we screwed up the rheostat a little, and kept the lamps in the station looking about right."

Edison has emphasized the value of continuous research work and given us a vision of the future in the science and art of electric lighting. "No invention is perfect," he says, "and the incandescent lamp is not an exception. Light without heat is the ideal, and that is still far off. The electric incandescent lamp of today is the cheapest form of filament that has ever been produced, but some day it will be cheaper and colder than it is. There is a good deal of truth in the saying that the firefly is the ideal. It is, so far as coldness goes. But its color is against it. You couldn't use a thousand candle firefly to match colors, and you wouldn't want the insect to light up a street, because his light would be a hideous greenish yellow. But some day we will get reasonably near the firefly for efficiency without copying his disagreeable color. The task needs much investigation, much research of the kind we did in 1879. The research that we began then is still going on, and it always will go on. Somehow, each new discovery opens up the way to another."

Some Properties of the Rotary Converter*

CURRENT RELATIONS, POINTERS ON OPERATION, OSCILATING AND SPEED LIMITING DEVICES AND CONNECTIONS. BY O. H. HENSCHEL

IN studying the behavior of rotary converters, we find that this type of machine in many respects acts not unlike the synchronous motor, as to its intake of alternating current or currents. With a given load on the machine, the intake of current varies with the degree of excitation, this being a minimum at unity power factor.

In the case of a 2-ring or single-phase converter, the direct-current output is equal to the product of the current flow times the voltage across the brushes or $E\,I$, where I is the current flowing in amperes, and E the voltage across the brushes. Similarly with a power factor or unity, the intake on the alternating-current end is equal to the product of the current flowing in amperes times the voltage across the collector ring brushes or $E_2\,I_2$, where I_2 is the current flow in amperes, and E_2 the voltage across the brushes. Neglecting all machine losses, we have $E_2\,I_2$ equal to EI.

We have found, however, in our discussion on the subject of voltage relations of 2-ring machines, that the effective value of the alternating electromotive force, E_2, between the collector ring brushes is equal to the direct-current voltage E divided by $\sqrt{2}$, or E_2 equals E/1.414, or equals 0.707E.

Substituting the value of E_2 in the above power equation, we have $0.707\,EI_2 = EI$, or $0.707I_2 = I$, thus showing that in a 2-ring converter the current delivered by the direct-current brushes is equal to 0.707 times the current delivered to the collector ring brushes.

Now for the 3-ring or 3-phase machine, the current output as before is EI, but the power intake is $\sqrt{3}\,E_3\,I_3$, where E_3 is the voltage across each collector ring and I_3 the current flowing in each main, so that $\sqrt{3}\,E_3\,I_3 = EI$.

From the preceding argument we find, however, that E_3 is equal to $0.612\,E$, which upon substitution in the power equation of the 3-ring converter causes that to read $\sqrt{3} \times 0.612\,EI_3 = EI$, or $\sqrt{3} \times 0.612\,I_3 = \mathrm{I}$. This in its final form gives us $I_3 = 0.943\,I$.

Likewise, for a 4-ring machine, we have $I_4 = 0.707\,I$ and in a 6-ring machine, $I_6 = 0.471\,I$.

RATING OF CONVERTERS

ARMATURE REACTIONS of this type of machine being negligible, it follows that the rating of a converter is entirely dependent upon the armature heating, or, in other words, the RI^2 losses or copper losses of the armature windings. Power rating of a converter is generally expressed in terms of rating the same machine when used as a direct-current generator. In the curves of Fig. 6 are shown the ratings of converters at various power factors compared to those of direct-current generators as unity. From these curves we find that with a power factor of 1.0 or 100 per cent, a 2-ring converter has a rating of about 0.85 that of the same size of machine when used to deliver direct current, while 3 and 6-ring converters are capable of delivering 1.32 and 1.92 times the amount of energy which a direct-current generator of like dimension can deliver.

Relation between direct current I delivered at commutator end and effective value of alternating current delivered to each collector ring.	$I_2 = 1.414\ I$ $I_3 = 0.943\ I$ $I_4 = 0.707\ I$ $I_6 = 0.471\ I$
Relation between voltage across direct current brushes and effective values of alternating electromotive force between collector rings.	$E_2 = 0.707\ E$ $E_3 = 0.612\ E$ $E_4 = 0.500\ E$ $E_6 = 0.354\ E$

Subscripts 2, 3, 4 and 6 refer to 2, 3, 4 and 6 ring converters respectively.
I and E represent current and electromotive force values respectively on direct current end.

FIG. 5. THEORETICAL CURRENT AND VOLTAGE RELATIONS OF ROTARY CONVERTERS

*Continued from page 920, Oct. 1 issue.

Operation

Rotary converters may be started by any one of 3 methods. The first is similar to that used to start synchronous motors, namely, the supply of polyphase alternating currents to the collector rings, the armature being brought up to full speed as an induction motor. The power value of impressed voltage is obtained from taps on the windings of the transformers between the supply lines and the converters.

Considerable care must, however, be taken when this method of starting is employed. With the alternating current flowing through the windings of the armature, these act as the primary of a transformer, whose secondary is made up of the shunt field windings, the insulation of which is placed under heavy and dangerous strain. To eliminate this danger and also for other reasons mentioned later, these windings may be broken up in several places by means of a so-called "field breakup and reversing switch" ordinarily mounted on the frame of the converter.

When a shunt to the series coils is employed, this also should be opened at starting, as otherwise the heavy alternating current produced in it and the series windings may cause excessive heating, and by its breaking effect may also hinder starting.

This method of starting converters is extensively used, and while it has the advantage of making synchronism unnecessary, it requires a large starting current, which if the converter is large as compared with the driving alternator causes an excessive voltage drop throughout the entire system.

fore, several converters are to be connected in parallel, or if in the case of a single converter it is necessary at all times to keep one side of the line positive and the other negative, it is of vital importance to try out the polarity of the machine before throwing it onto the line. If the machine happens to come up to speed with the wrong polarity, the field breakup switch must be thrown

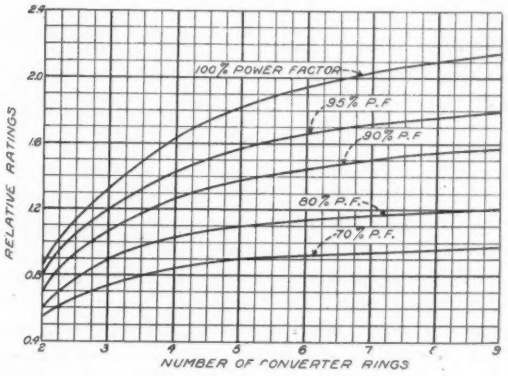


FIG. 6. RATINGS OF CONVERTERS AT VARIOUS POWER FACTORS COMPARED TO DIRECT CURRENT GENERATORS AS UNITY

from one position to the other, thereby reversing the field, consequently the polarity of the converter.

Small induction motors mounted on an extension of the converter frame are used to a considerable extent for starting purposes. Such a motor is, as a rule, provided with a fewer number of poles than is the con-

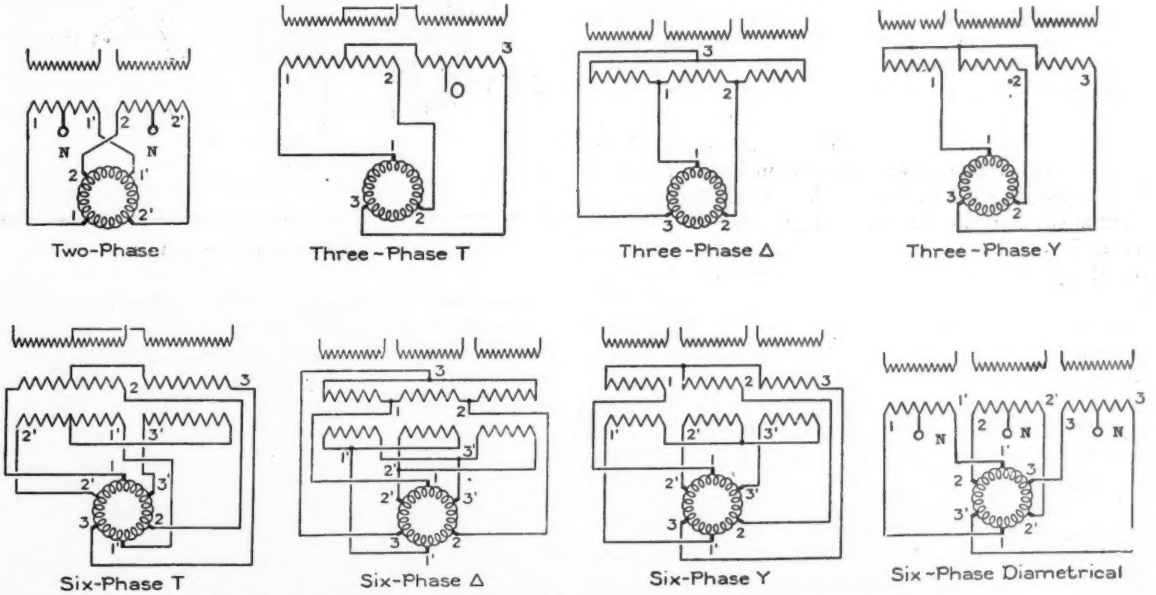


FIG. 7. METHODS OF CONNECTING TRANSFORMERS TO ROTARY CONVERTERS

When starting a converter by this method, it is possible that a particular direct-current brush or set of brushes may be positive or negative, according to the direction of the last impulse of the alternating current just before the machine goes into synchronism, thereby making it impossible to determine which brush or set of brushes will be positive and which negative. If, therefore, several converters are to be connected in parallel, or if in the case of a single converter it is necessary at all times to keep one side of the line positive and the other negative, it is of vital importance to try out the polarity of the machine before throwing it onto the line. If the machine happens to come up to speed with the wrong polarity, the field breakup switch must be thrown from one position to the other, thereby reversing the field, consequently the polarity of the converter.

verter, so that it will be able to bring the converter up to full synchronous speed. Thus a 12-pole converter would require a 10-pole starting motor, so as to produce a slip of 16⅔ per cent; a 10-pole converter requires an 8-pole starting motor with a 25 per cent slip, and an 8-pole converter takes a 6-pole motor for a 33⅓ per cent slip.

When the station equipment and operating conditions permit, a converter may readily be started as a motor from the direct-current side, receiving its starting current either from a storage battery or bus bars connected to other operating machines. A device for automatically tripping the direct-current circuit breaker upon closing the alternating current switch has proved a valuable addition to the equipment for converters started by this method.

Rotary converters are synchronized and placed in parallel operation in much the same manner as any alternating-current generator or synchronous motor.

Oscillators

Unlike other electrical machinery, such as alternating or direct-current motors and generators, the revolving members of which are subject to some form of external force from belts, gears or crank shafts, which tend to produce a more or less regular oscillation of such revolving members along the axis of the shaft, the armature of a rotary converter when revolving with its shaft horizontal will usually assume a fixed position relative to the bearings and frame of the machine. Due to the lack of shaft play, the brushes wear grooves in the commutator or collector rings, so that some form of automatic oscillator must be provided.

An effective device much used is an electromagnet mounted opposite the end of the converter shaft. This electromagnet is excited a given number of times per minute, and each time gives an endwise pull on the shaft, causing the desired play.

Another oscillator used by one of the large electrical manufacturing companies of this country is a self-contained device carried at the ends of the shaft. The operating parts consist of a hardened steel ball and a steel plate with a circular ball race, backed by a spring. This is so mounted that the face of the plate is not quite parallel to the face of the end of the shaft. The machine is installed with a slight inclination toward the end carrying the oscillator. The steel plate is then so adjusted that the ball is in light contact with the race and shaft. As the armature revolves, the ball is carried upward and owing to the convergence of the steel race and shaft face, the spring is compressed. The reaction of the spring forces the armature away from its natural position and allows the ball to drop back to the lowest point of the race.

Under the impetus received from the spring, the armature continues to move horizontally until opposing forces bring it to rest, when it is returned by gravity and the cycle repeated.

Speed Limit Devices

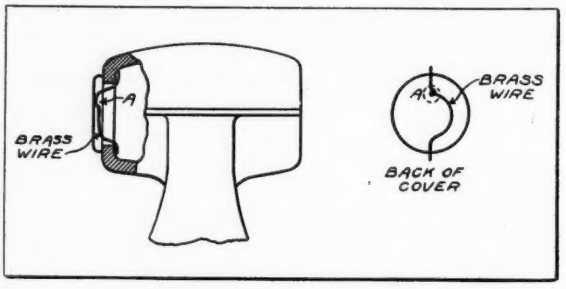
When driven from the alternating-current side, the speed of a rotary converter is a function of the frequency of the supply current; but when driven by the direct-current end as an inverted converter, its speed varies with the voltage and field strength, the same as in any direct-current motor. As a safeguard against any possible overspeed, various kinds of speed limiting devices are employed. One of these consists of a spring-closed knife-switch actuated by a centrifugal tripping mechanism, which may be attached to the same end of the shaft as the oscillator. The knife switch is held open by a pivoted latch, so arranged that when the simple centrifugal governor attached to the shaft operates at a predetermined speed, it trips the latch and releases the spring, thus insuring a quick and positive closing of the switch, which generally is mounted in a metal box attached to the bearing housing and which completes an auxiliary circuit through the tripping coils of the direct-current circuit breakers.

Transformer Connections

No general directions can be given regarding this subject, as the method of connecting the converters to their transformers depends upon the style of machine, the kind of circuit, whether 2, 3 or 6 phase, and whether or not the converter is to be started by the alternating-current end as an induction motor. A number of methods of connecting transformers to rotary converters is shown in Fig. 7.

Dust Protector for Motor Bearings

A MOTOR ran in a dusty place, so, to keep dust out of the bearings, a cover was made as follows. A piece of galvanized sheet iron was cut into the form of a circle and a slight flange turned on the edge. A piece of brass spring wire was bent as shown in the 2 views, and soldered as at A. Then the lower end hooked in and



DUST GUARD FOR MOTOR BEARING

pressed down till the upper end would enter, when the spring of the wire held it in place. It was then painted and looked as if part of the machine, although it could easily be removed at any time. It took only a few minutes to make several. H. E.

Meetings are being held in all parts of the country to perfect arrangements for Electrical Prosperity Week. and members of the staff of the Society for Electrical Development have been meeting with clubs and conventions in various cities. J. M. Wakeman, General Manager of the Society, has attended meetings in Kineo, Me., Dayton and Cincinnati, O., Bedford Springs and Pittsburgh, Pa. H. W. Alexander of the Society has visited Chicago, Toledo and Cleveland, and also addressed a meeting of contractors in Boston. Other members have spoken in Toronto, Niagara Falls, Scranton, Springfield and Boston, Mass., Portland, Ore., and Asheville, N. C. At all points, cooperation and support of Electrical Prosperity Week have been pledged.

GAS POWER APPARATUS

Producers, Engines and Industrial Applications

Diesel Engines for Generator Drive*

REPORT OF INVESTIGATIONS RELATIVE TO OPERATION OF DIESEL-ENGINE-DRIVEN ALTERNATORS. BY C. LEGRAND

LATE in the year 1912, the writer investigated the suitability of Diesel engines for driving generators of 500 to 100-kw. capacity under conditions generally prevailing in mining camps in the Southwest. At that time no American-made engines of sufficient size were available and the investigation was carried on in Europe, mostly in Belgium.

Four-cycle engines of 175 effective brake horsepower per cylinder, had been in use for several years and the results of their operation known. Cylinders of 250 effective brake horsepower were made, but I did not see any.

Two-cycle engines of 250 effective brake horsepower per cylinder, had been in operation for a short time, but no data as to maintenance or repairs was available. Engines with cylinders of 600 effective brake horsepower were under construction after shop experiments had been carried on with one single cylinder of that size. One cylinder of 1000 effective brake horsepower was being experimented upon, and builders were ready to take orders for engines using this size cylinder. All of the above cylinder ratings were for sea level conditions. The 4-cycle engines inspected had trunk pistons air-cooled. The 2-cycle engines had water-cooled pistons with crosshead and slides.

All engines used forced lubrication for cylinders. Both types were used successfully to drive alternators in parallel, the generators being equipped with damping windings. For a given number of cylinders, the 4-cycle engine required a heavier flywheel. Heavy oils could be used in both types with proper arrangement for heating the oil and using a light oil at start and finish of a run.

The fuel consumption per brake horsepower of a 4-cycle engine is from 7 to 10 per cent less than that of the 2-cycle engine, depending on the load and, for both types, is practically independent of the size of the engine.

The 4-cycle engine is simpler, having no scavenging pump or moving water connections to the piston.

The 2-cycle engine has no exhaust valve, the exhaust taking place through ports in the cylinder wall; this is an advantage when using oil containing sulphur, as the exhaust valve is principally affected when sulphuric acid is formed in the cylinder and condenses on the seat of the exhaust valve, requiring frequent grinding of this valve.

*From a paper read before the A. I. E. E.

The scavenging pump is an advantage on engines to be used at high elevations, as by increasing the size of this pump, the pressure in the cylinders at the beginning of the stroke can be increased above atmospheric pressure and restore sea level conditions, if found advisable, at a comparatively small increase of fuel consumption. This could be done on 4-cycle engines by the addition of an air pump, but would complicate this type of engine.

The lubricating oil consumption of 4-cycle engines is higher per horsepower than that of the 2-cycle engine. The total consumption of lubricating oil of a 525-hp., 3-cylinder, 4-cycle engine in actual practise being approximately 5 gal. per brake horsepower-year of engine rating, while that of a 5-cylinder 2-cycle engine of 1250 brake horsepower is 2.5 gal. per brake horsepower-year, both being on sea level rating of engines and for continuous service.

The proportion of cylinder oil to engine oil used in the 2-cycle type seems to be greater than in the 4-cycle. In the 4-cycle, the cylinder and engine oils used are about the same, according to builder's statements, while in the 2-cycle, the cylinder oil is approximately twice the engine oil from actual practise during 3 months.

The 4-cycle engine takes a little more room and is heavier than the 2-cycle engine of the same power.

Briefly stated, the advantages of the 4-cycle engine were: well established type with known maintenance and repair costs, smaller fuel consumption, greater simplicity; those of the 2-cycle engine were: less lubricating cost, steadier running, less liability of trouble from sulphur in fuel oil, greater output per cylinder, less cost per horsepower especially at high altitudes.

After due consideration, the company with which I am connected decided to try the 2-cycle engine in actual practise, and 2 5-cylinder engines rated at 1250 brake horsepower at sea level, direct connected to 815-kv.a. 6600-v., 3-phase, 180-revolution generators, were installed. One of them has been in operation since December, 1914, and the other since March, 1915; the load at present is so small that only one engine is operated at less than 25 per cent capacity, and it is too early to give any results of operation; however, from the numerous tests which we have made parallel operation is quite easy.

The exciters are direct connected to engines and run in parallel on the regulator.

Before paralleling the generators, the exciters were run in parallel for half an hour, one engine having a

slightly variable load of 90 kw. and the other no load. The variation of load on the 2 exciters did not exceed 10 amp. from the average of 90 amp.

The 2 generators were then paralleled on a total load of 90 kw. and the variation of load between engines could hardly be seen on indicating wattmeters. After a sufficient length of time to satisfy ourselves that there was no difficulty in parallel running, we cut off the fuel supply on one cylinder of one engine, then on 2 cylinders. With one engine running on 3 cylinders and the other on 5 cylinders the load varied approximately 30 kw. between the 2 engines, after the governor had been adjusted to divide the load about equally. This test was then repeated after increasing the total load to 200 kw., with the same results. Later on, the 2 engines were connected in parallel, then the fuel supply was cut off altogether on one engine, running its generator as a motor; the fuel supply was then put on again, but we have been unable to make the generators fall out of step and they behave much better than any compound steam engines with which the writer has had experience. The current readings were too small to get reliable data on interchange of current between generators.

The engines use California crude oil of about 16 deg. B gravity, heated to 120 deg. F. by means of the circulating water of the engines, except at start and finish of a run, when a lighter oil is used so that it will flow when cold.

Regarding cost of installation as compared to a steam plant, this has to be figured for each particular case. The character of the load has an important bearing on the total capacity of generating machinery to be installed.

With a steady load the total capacity of units is practically the same, as both have the maximum efficiency at rated load.

With a variable load subject to high peaks, the Diesel engine plant would require a greater capacity than the steam plant, as like all internal combustion engines, the Diesel engine has little overload capacity.

With conditions prevailing generally in Arizona, on rated capacity of plant installed for total power between 1000 and 2500 kw. the cost of a Diesel engine plant compares favorably with a high grade steam plant using condensing Corliss engines, superheater and economizer in boiler plant.

In designing a Diesel engine plant it is well to remember that the fuel consumption per effective brake horsepower is practically independent of the size unit used, that an engine can be started and put under full load in a short time so that a greater number of units can be used if it suits the load conditions better.

Development of the Crude Oil Engine

THE WEISS ENGINE; THE KEROSENE CARBURETOR. BY SAMUEL M. HOWELL

PATENTS taken out by Carl W. Weiss at various times since 1896 represent a high order of inventive talent, and from the theoretical basis of an established system of manufacture. These engines are of the 3-port 2-cycle class, and with one exception are intended for the use of oil fuel. The crank case is the preliminary compression pump, as usual, but it receives air only, the fuel being admitted directly to the combustion chamber; and thus some desirable features of the 2-stroke principle are secured without the disadvantages of former methods. These patents are quite numerous, but only those which are deemed of special interest are shown here.

The patent of Oct. 19, 1897, No. 592,033, C. W. Weiss. This engine is intended for the use of gas fuel, and is shown in Fig. 1. A is the exhaust port, b the crank case inlet for air, c the cylinder admission port, and d the air valve. E is the cylinder head, and a hot tube ignitor. The gas is piped to a connection which communicates with the cavity g in the rear of the air valve, and cannot escape therefrom as long as this valve remains closed; but, as the crank is turning the outward center, and the exhaust has been diseharged, the air valve is forced open by the push rod h and a volume of air from the crank case enters the combustion chamber through the port c, accompanied by a charge of gas drawn in by way the cavity g, and since the flow of gas is induced or aspired by the current of passing air, and the force of this current is proportionate to its volume, it is evident that the respective amounts of air and gas will always bear the same relation to each other, and although the quantity of the resulting mixture may vary somewhat, its strength or quality will remain uniform. After the admission of the charge the air valve is immediately closed by the spring i, and the mixture strongly compressed by the return movement of the piston is forced through the recesses of the cylinder head into the ignitor tube and there fired. These radial recesses or channels in the head are shown in the figure, and their purpose is to conduct the gas first fired in the tube to the main body of the charge in the cylinder, and there ignite at a number of different points at the same instant, the inventor claiming that by thus affecting the ignition at several points over an extended area, he secures more rapid combustion and a higher degree of efficiency.

Another peculiarity of this construction is the retarding chamber j, shown in Fig. 1, as a coiled tube, in communication with the ignition tube, and also with the combustion chamber through the channels above mentioned. The office of this device is to prevent the ignition of the charge until the piston has reached the end of its inward movement, and its action is as follows: To fill this chamber the gas in the cylinder is driven backward through the channels of the head, and by reason of the vacancy in the chamber, and the force of compression, this current of gas travels more rapidly through these restricted passages than the flame moves forward, and thus the ignition of the main body of the charge within the combustion chamber is delayed until the compression movement has been completed, and the piston is in position for the power stroke.

The small spring seated valve shown at k in the figure is the auxiliary air valve. It is opened for

an instant by the pressure of the air in the crank case immediately after the exit of the exhaust, and prior to the opening of the main air valve. In this interval it discharges a small volume of air through the port c and drives out any remaining flame which might otherwise linger therein, and fire the succeeding charge as it entered the cylinder. The same patent also describes a modification, in which the admission is piston controlled, and the air valve is not used.

Another patent of Weiss on the same date as the above and numbered 592,034 is of the same general structure, but provides for the use of oil fuel, and the engine is self-igniting; it is not shown.

The patent of July 15, 1902, No. 704,995, C. W. Weiss (not shown), provides for the introduction of water into the combustion chamber, to prevent preignition, and to scavenge the cylinder of dead gases by means of the steam thus generated. The water is injected at the cylinder admission port after the opening of the exhaust, and an instant before the introduction

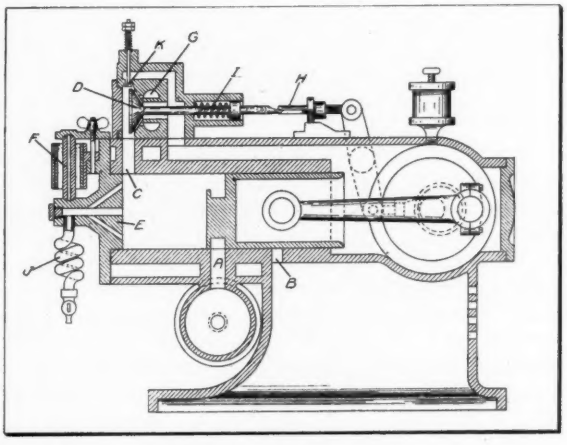


FIG. 1. CROSS-SECTION OF WEISS GAS ENGINE

of the fuel. This patent within the limits of its application is a document of some importance, as it covers the injection of water into the combustion chamber of a 2-stroke mixed compression engine (having a ported cylinder) in the interval between the opening of the exhaust port and the introduction of the fuel. The method has been more recently improved, however, and these engines are now scavenged by steam generated from the waste heat of the water jacket, the arrangement being such that the temperature of the water in the jacket never rises much above the boiling point.

The patent of April 18, 1905, No. 787,709, C. W. Weiss. This engine, shown in Figs. 2 and 3, contains a form of the hot bulb ignitor now largely used, and has also an improved fuel nozzle, the latter being shown on an enlarged scale in Fig. 3, and at a in Fig. 2. This nozzle includes a chamber b which opens into the combustion space through a hole, c, at the base. On the compression stroke the air enters through this hole and fills the chamber under a strong pressure. As the crank is turning the center, the fuel pump forces in a charge of oil past the valve d. When the piston begins to move forward this valve closes, and the air confined within the chamber now rushes out through the hole c and carries the oil in the form of a mist into the combustion space. Thus the fuel charge is atomized by a blast of air secured in a very convenient manner.

The bulb e, as may be seen, has a lip or extension, f, on its under side. This lip is directly under the fuel nozzle, and always receives a portion of the oil charge as it issues from the orifice, this part of the charge being driven by the air on the compression stroke, into the bulb, where it is fired, and unfailingly causes the ignition of the main charge at the beginning of the outstroke. This lip or extension is used by several manufacturers, and is known as the ignition spoon. It is not, however, an exclusive feature of this patent, but was first claimed in Patent 680,953, Aug. 20, 1901, C. W. Weiss.

A peculiar arrangement is described in the patent of June 13, 1905, C. W. Weiss, No. 792,300 (not shown). In this construction the cylinder admission opens in advance of the exhaust, and the burnt gases are discharged into the crank case, or by a modification into an auxiliary chamber, and when the exhaust port opens an instant later the spent gases return to the combustion chamber

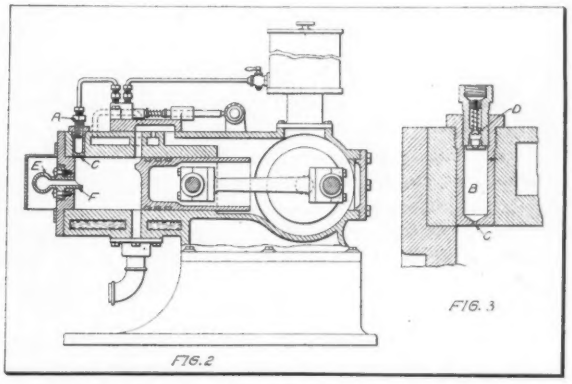


FIG. 2. WEISS ENGINE WITH HOT BULB IGNITOR
FIG. 3. IMPROVED FUEL NOZZLE

and pass out, followed by the air of the crank case, and this fills the cylinder while the exhaust port is closing.

The effect of this is that the pressure of the exhaust is so far reduced that its final exit is almost noiseless, and the use of a muffler is not necessary, and also the more forcible discharge of the contents of the crank case thus brought about, causes a violent agitation of the air and gas in the cylinder, and results in a more perfect mixture.

The Kerosene Carburetor

This is a modification of the ordinary carburetor, by means of which kerosene or distillate may be used in automobile and other engines originally intended for gasoline. There are at least 3 of this class of carburetors manufactured on a large scale at the present time. They are the Hampton, the Holly and the Harroun. A large number of these makes are now in use with entire success, and there are no doubt other constructions of the same character that are also fully dependable. The general principle employed is to heat the entering air and gasify the oil by means of the exhaust, but in the Harroun arrangement a special feature has been introduced. That is, by means of a bypass controlled by

a small lever on the dashboard or steering wheel, a portion of the exhaust is mixed with the charge, and returned to the combustion chamber. This seems to have the same effect in some ways as the injection of water, and it is claimed that combustion is thus retarded to such an extent that preignition will not occur, and on account of the lower rate of flame propagation the engine may be economically operated at low speeds.

The Higgins is another well-known oil carburetor, and is a much older device than those named above. This carburetor has been used for years past on portable and other engines of the agricultural class. It supplies air, water and oil spray, in definite proportions, which are varied and controlled by the engine governor to suit the different conditions of speed and power output, in such a way that a correct mixture is furnished at all times. (To be continued.)

Speed and Load of the Gas Engine

FACTORS DETERMINING SPEED; RATINGS. BY E. W. LONGNECKER

THE speed or number of revolutions per minute a gasoline engine should make is a puzzle to many operators. Almost everyone of extended experience has had to learn at some time or other that the speed of his engine was limited and that he could not speed it above a certain point under a certain load. Somehow or other the belief has become pretty generally established that when the load becomes too heavy for a gas engine at a certain speed, all that is necessary is to increase the tension of the governor springs, that is, "screw down the governor," and the engine will speed up and carry the overload right along. Here is where a disappointment is encountered. The engine will not speed up; first, because its load is too heavy, and second, if it is running up to its normal speed, the valve areas are probably not sufficient to allow of increased respiration necessary to accommodate the increased speed of the engine. The valve areas are usually figured and based upon a certain piston speed and when the engine has reached that limit it is not possible to carry a load beyond that speed to any degree of success. Increased speed means filling of the cylinder with a charge of gas in a shorter period of time and also getting rid of the exhaust gases in a correspondingly shorter period. If the speed of the inlet and exhaust gases are at their limit for the successful filling of the cylinder and proper exhaust then an increased piston speed will cut the time too short for successful filling and emptying. This results in a short power impulse and back pressure because the exhaust can't get away quick enough to allow free return of the piston.

The majority of inquiries for help on this point suggest the increase of the size of the engine belt pulley as a possible remedy, when in reality this will make matters worse because of the increased load put on the engine by the increased speed of the machinery driven. The engine will be pulled down lower in speed because of the increased load. A gasoline engine may be capable of speeding up beyond its rated or normal speed if the valve areas have been constructed to permit of a full inlet and free exhaust at a higher piston speed than its normal rating which is not always the case.

A full charge of the proper mixture of fuel exploded or ignited at the proper time gives the most effective power impulse, and then if the exhaust passages are sufficient in size to let out the burnt gases promptly during the exhaust stroke of the piston the greatest amount of power will be gotten from the volume of fuel used.

It has not been readily understood why the gas engine is more easily overloaded than a steam engine. This is because the gas engine is usually sold at its brake test power while the steam engine is sold at a nominal power based upon an intermediate boiler pressure. An increased boiler pressure increases the power of the cylinder. Thus we have increased power in the steam cylinder just as long as we are willing to risk firing and running up the pressure in the boiler. Then the rule is, when the steam engine is lagging under its load, to fire up, run up the steam pressure, increase the speed and rush things through. If the gas engine has an overload, the best plan to follow is to reduce the load and let the engine carry it along easily, because there is no way to run up the pressure and get more speed and consequently more power.

The manufacturer of the gas or gasoline engine might establish a different power rating for this type of engine, say at ⅔ of its actual brake test, and then proclaim its ability to carry a ⅓ overload. Or the purchaser might secure an engine with ⅓ more power capacity than he figures that he needs so that in case of a rush effort he will have sufficient reserve power to meet his demands. In the former case, the manufacturer would give his 15 b. hp. a rating of 10 hp. and sell it to the consumer at that rating. The operator in that case would have the advantage of 5 hp. surplus for emergencies, and could speed up and carry an overload of from 1 to 5 hp. On the other hand the wise purchaser, knowing that the gas engine is sold at its actual brake power rating, may solve his load and speed problem by buying an engine with power capacity considerably in advance of his actual needs.

In good running order the gasoline engine will never want for speed unless it is overloaded, and if it is overloaded it can not be made to speed up with a vim and "jerk the puddin' out of its load," either by screwing down the governor or changing pulleys, unless it has reserve power capacity. The way to secure this, is to select an engine with enough greater capacity than is needed for the heaviest load in present view. Then it is ready for greater effort without the spur of governor or throttle.—Gas Power.

BUREAU OF MINES, Bulletin 94, United States Mining Statutes Annotated, by J. W. Thompson, 1722 pp., has lately been published. The bulletin is intended for persons engaged in mining enterprises that come within the scope of the Federal mining laws, and as a guide in the determination of mining rights and duties. It shows the status of every Federal mining law, both laws relating to metal mining and those relating to coal, oil, and phosphate, and to mining on public, Indian, and railroad lands.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Cracked Water Jacket

SOME TIME ago I had a rather peculiar experience with a 50-ton horizontal ammonia compressor which was directly driven by a Corliss engine and was a dry compression machine of the type having the water jacket and compressor cylinder cast in one piece. The circulating water for the compressor entered at the bottom of the jacket through a 1-in. line which was tapped into the water line serving the ammonia condensers with

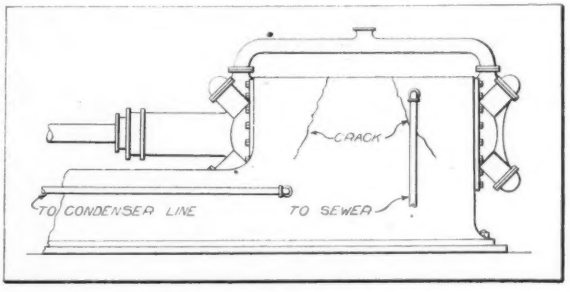


FIG. 1. CRACKED WATER JACKET ON AMMONIA COMPRESSOR

condensing water. (See sketch.) The overflow line from the jacket was tapped in near the top and drained into the sewer.

The day that the accident happened was very cold and windy. The compressor was freezing back rather heavy and the circulating water over the ammonia condensers was shut off in order to warm up the machine a

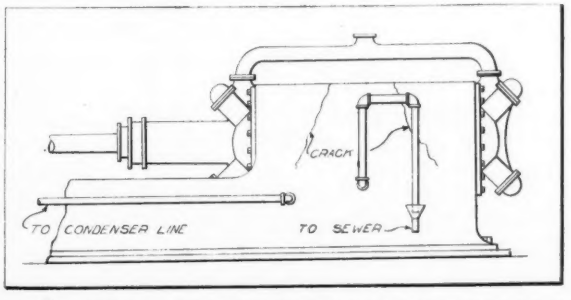


FIG. 2. PIPING TO PREVENT WATER JACKET FROM FREEZING

bit. When the condenser pump was shut down, there was no circulation of water around the compressor jacket and the water in the jacket froze solid and cracked the jacket in 2 places, as shown in the sketch. The cracks were about 18 in. long. These cracks were not noticed until the ice in the jacket melted.

When the compressor warmed up, there was considerable leakage of water around the machine, and in looking around for the cause of this, the 2 cracks were found. To avoid a repetition of this, I made a siphon outlet from the jacket, as shown in Fig. 2.

In case the water is shut off the jacket line, the siphon outlet will drain the jacket and prevent a freeze up. When using the jacket water on the compressor, I keep the overflow running full stream; this I ascertain by having the discharge or overflow running into a funnel where it always can be seen.

The cracks in the jacket were calked with a paste made of Smooth-on iron cement which made a tight and neat job. C. E. ANDERSON.

Ventilating the Engine Room

THOUGH OUR boiler room was well ventilated, being all doors or windows in front of the boilers, the engine room was extremely warm in the summer months. It was well filled with pumps, engines, dynamos and 2 generators of the absorption refrigerating system.

The engine room crew had sweltered in the 115 deg. of heat for many years without finding any method of ventilating the room until the Parsons system of forced

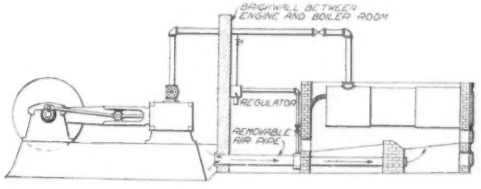


FIG. 1. FORCED DRAFT SYSTEM VENTILATING ENGINE ROOM

draft was installed under the boilers in order to use hard coal screenings for fuel. The jets were placed at the back of the boilers, the tube running through the back wall beneath the combustion chamber to the ashpit beneath the grates.

This reduced the temperature in the passageway back of the boilers so immensely that we decided to cut through the wall and connect the 9 blower inlets to exhaust the air from beneath the floor of the engine room, which was about 3 ft. above the earth. The result was more than expected. The temperature was reduced 11 deg. with 5 boilers running, and 15 deg. with 7 boilers running.

In a plant which the writer visited soon after it was constructed, at the end of the court between 3 7-story buildings, a 24-in. pipe was run from the entrance to the engine room to the top of the 7-story building. But the temperature of the engine room was almost unbearable, running as high as 125 deg. The engine and boilers were on the same floor line about 16 ft.

below the pavement. The roof of the boiler room was about 10 ft. above the pavement at the extreme end of the court and the only air admitted came through the 3 by 5-ft. windows above the pavement. The engine room with 4 engines and 6 dynamos was beneath the pavement. Though there were 3 hatches at the curbstone on one side of the engine room, they were all shut tight to keep the dirt from the machinery and what air entered through the windows passed down only far enough to enter the open end of the 24-in. pipe leading to the roof without cooling either the engine or the boiler room.

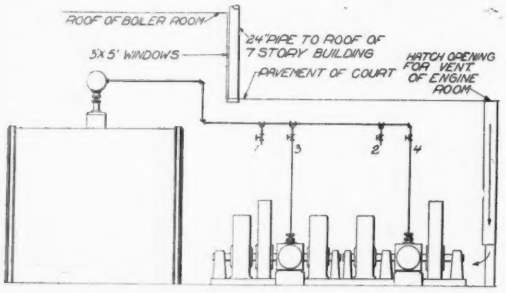

ROOF OF BOILER ROOM
5'X 5' WINDOWS
24" PIPE TO ROOF OF 7 STORY BUILDING
PAVEMENT OF COURT
HATCH OPENING FOR VENT. OF ENGINE ROOM

FIG. 2. VENTILATING SCHEME FOR BASEMENT ENGINE ROOM

The writer suggested that one hatch at the rear corner of the engine room be removed and a sheet metal duct from it brought down to 24 in. above the floor, which would prevent any dust from the pavement being scattered over the apparatus in the room and at the same time create a wider circulation. A week later I called to see the engineer and found a very cool engine room. When I looked for the system of ventilation, he explained that the architect and superintendent had carried out my suggestion. R. A. CULTRA.

Care of Blowoffs

IN THE ARTICLE by Luke Marier, in Sept. 1 issue, on the care of blowoffs, he didn't make it quite clear as to how the tightening of stuffing-box nuts on a blowoff valve would cause an explosion with only 10 lb. pressure on.

I think Mr. Marier, in his advice to young engineers, should have said, "Don't tighten up on blowoff valve stuffing-box nuts under pressure except when you know that the blowoff valve is in good order with good packing in."

How many engineers are there that don't tighten up their stuffing-boxes on high-pressure valves of all kinds while under pressure? J. H. C.

[Here is another who would take a chance. No amount of warning seems sufficient to prevent dangerous and uncalled-for risks.—EDITOR.]

Governor Gagpot Repair

IN THE Aug. 15 issue, page 787, there is a repair on a governor gagpot that I think I should have accomplished in another way.

Drilling holes in the piston was the proper thing to do, but I should not have used the pump valves, as the same result could be obtained by drilling half as many holes and not using the pump valves.

It once fell my lot to run a Corliss engine and I thought the governor was not sensitive enough, as the lights in the mill were not steady, so, to make the engine regulate more closely, I drilled several holes in the piston of the gagpot. As this made the engine too sensitive, I tapped out several of them and put in some machine screws until the engine ran to suit me.

An engineer cannot always find pump valves, but he will always be able to find machine screws about the plant.

I would suggest that Mr. Broadaway try this method if he has any more trouble with his governor. I always used engine oil in the gagpot, as we usually had plenty.

HARRY H. JOHNSON.

Slamming Pump Valves

I READ with much interest the article of Mr. Kaunitz on this subject and I wish to say that at the present time I am operating 4 vacuum pumps of various sizes made by the Fairbanks-Morse Co., in which this type of valve is used.

On the 8 by 12 by 12-in. pump the valve seats are 4 in. in diameter. The valve consists of 3 plates or discs of hard brass. The bottom disc is 4 in. in diameter, and perforated with 6 ⅛-in. holes. The second disc is 3¾ in. in diameter with 4 holes and the top disc is 3¼ in. in diameter without holes. These discs are held in place by the usual stud and spring. They work quietly, but I find one disadvantage in their application to the pumps in question, namely, excessive wear on the studs and holes in the discs.

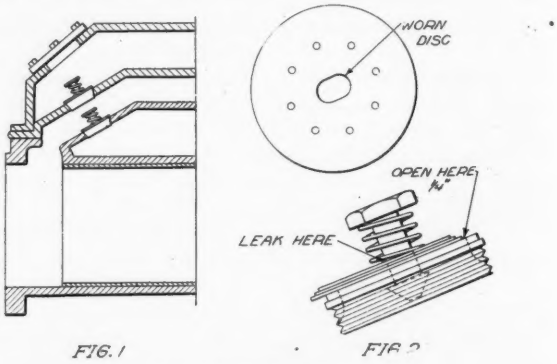


FIG. 1. LOCATION OF VALVES IN PUMP
FIG. 2. RESULTS OF WEAR

The accompanying sketch shows a section of this pump. It will be seen that the center line of valve seats instead of being vertical is placed on an angle of about 30 deg. from the vertical. After these pumps had been in use for a considerable length of time, one of them would not hold the vacuum up to the required point without running the pump at an excessive speed. The piston was repacked without obtaining the desired results, then the valves were examined. We found these valves were seating properly and that the faces of the lower disc and valve seat were in good condition and not cut, but that the action of the valve on the stem had worn the hole oblong and also had cut the stud to such an extent that the upper part of the port was uncovered as shown in Fig. 2. Had these seats been horizontal, this

cutting would not have occurred. New valves and stems were purchased and put in, which entirely cured the trouble. Upon examination of the valves in the other pumps, we found the same condition present, but to a lesser degree. I have never used this type of valve for high pressure, but believe that it would give good results, in that it would not break and chip off. It seems to have enough elasticity to fit an uneven seat, and being as hard as the seats, would tend to wear both to a smooth fit. When used for vacuum pumps, a small amount of grease works in between the discs, and forms a cushion which makes them work quietly at high speeds.

J. C. HAWKINS.

Question Scrap Book

ENGINEERS OR FIREMEN ambitious to rise to the top of the ladder must study hard and get the practical side as well. One trouble with the majority of men studying for an examination is that they do not know what to study about. They study something or other and think they know the rest, and while they probably do gain considerable knowledge, they go before the examiner and find they are not able to answer the questions, because they are not familiar with them. I therefore recommend that all seeking higher license cut out all questions and answers, or at least all questions they find published, and paste them into a scrap book. Keep looking over the questions and see if you can answer them satisfactorily to yourself. I have a book 9 by 11 in. that I use for this purpose and have a list of over 1070 questions.

W. N. L.

Consistent Gas Analyses Needed

THE WRITER is very much interested in an article in your Sept. 15 issue, entitled "Efficient Operation of Boiler Rooms," showing how a textile mill plant produces high economy with ordinary equipment.

In the article, however, on page 868, it is stated that while the flue gases are analyzed with an Orsat instrument occasionally, the results are so variable that the engineer does not consider the analysis of any great value. The writer feels that this statement may place the readers under some misconception as to the value of flue gas analysis, and it is for the purpose of correcting this erroneous impression that we are writing you.

The whole difficulty with that plant lies principally in the fact that they analyze their flue gases "occasionally." The fact that their results are so variable is a clear indication that something is radically wrong with their furnace operation, particularly in view of the fact that there is not much fluctuation in the load during the working hours of the day. If the analyses were taken regularly every day, say, at 5 o'clock, or possibly twice a day, the engineer would probably find very little variation unless, of course, something happened to be radically wrong. It is the object of the gas analyzer to discover poor furnace conditions, and as soon as he finds that these are wrong, it is up to the engineer to correct them.

It seems to the writer that the whole trouble with that plant lies in the following sentence taken from the article:

"The thickness of the fuel bed is carried at 7 in. and strict, definite rules as to the number of shovelfuls of coal and the intervals of firing are given the fireman when he first comes on the job, but as he becomes familiar with the operation of the boilers he is left to his own judgment in regard to details."

This is the whole trouble with the average plant. The fireman receives entirely too little supervision and his work is almost entirely a matter of "guess" or "perhaps."

Put a draft gage on his boiler and he has something definite to work on. Otherwise he will waste fuel and the plant will continue to lose money.

THE WILLIAM B. PIERCE CO.,
GEO. H. COREY.

Pipe Under Tension

REFERRING TO C. O. Sandstrom's criticism of my contribution in which I stated that an eastern designer makes his steam pipes a trifle short, I wish Mr. Sandstrom would read my letter again and assure himself that I did not say, "by some means, a stress is put in the piping when cold that produces an elongation of 1/10 in. for every 10 ft. of length." As Mr. Sandstrom shows with his computations, such a stretch would be ridiculous.

I do not know of any power station where the ends of pipe lines of this kind are held perfectly rigid in order that such a stretch would be possible, and I certainly would not propose such a design. The ends are always deflectable to some extent, and that fact should be taken into consideration.

Whether or not this method of design should be used depends entirely upon conditions. Personally, I wouldn't use it in a pipe line a mile long for that would mean a cold stretch of 4 ft. in the entire line; but in a line 100 ft. long I know I could safely use it, for there the total expansion and contraction would be only ½ in. on each side of the center, and with the line in tension before heating the expansion and contraction would naturally become less. Judgment must therefore be used in connection with the rule. And I am sure that in a pinch, regular expansion joints and pipe bends could be used in connection with the method.

I have not checked over Mr. Sandstrom's figures because I believe they are correct from his standpoint of reasoning. Should any designer think that 1/10 in. is too much, though, 1/20 in. would do very well also; but, by its use, we would again have some stress in the pipe line while under steam due to compression and bending.

This method is not my own, but I am convinced that where used with proper judgment it is a winner. The designer to whom I referred in my first letter is using it right along in connection with the design of large power stations. Where bends and expansion joints are necessary he uses them.

I am glad, however, that Mr. Sandstrom criticised the method as he did, for I did not think at the time of writing it that it would be understood in that way.

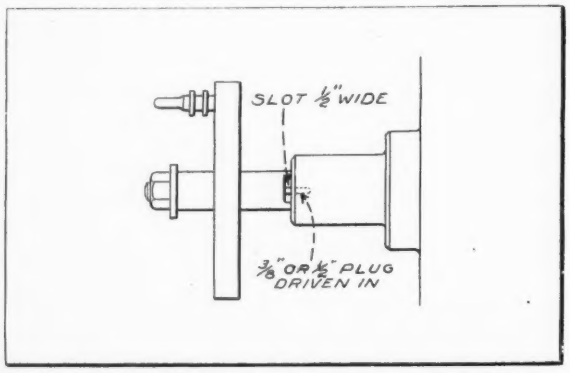
N. G. NEAR.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Trouble with Wristplate

WE HAVE had trouble with our exhaust adjusting rods on a 150-hp. Corliss engine getting bent, and the night engineer broke one of them on account of the wristplate being thrown too far and the rod turning under, when starting up. We took the wristplate off and

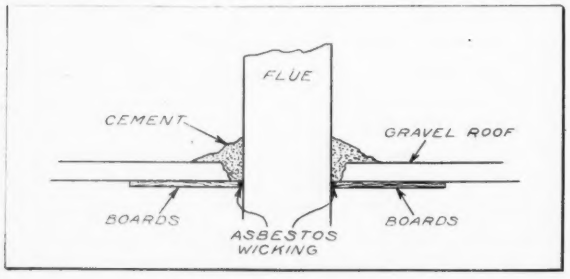


PIN TO PREVENT EXCESSIVE TRAVEL OF WRISTPLATE

filed a ½-in. strip as long as the throw of the valve, in the back face, as illustrated, and drilled a ½-in. hole in the cylinder bracket and drove a pin in the hole. We have had no trouble since, as the pin keeps the wristplate from turning too far. J. H. S.

Power Plant Repairs

ONE WAY in which an engineer can save money for his employer, is to carry the steam pressure to suit the load. By that is meant that, at certain periods in nearly all plants, the load is lighter than normal. For instance,



SEALING A LEAK AROUND A FLUE

a certain department will run overtime or will be the only one running after a part of Saturday morning, the others having stopped to clean up.

If the pressure is maintained as high as when full load is carried, the chances are that the engine will cut off so early that the steam will expand down below the atmospheric line, in which event the cylinder condensation is excessive.

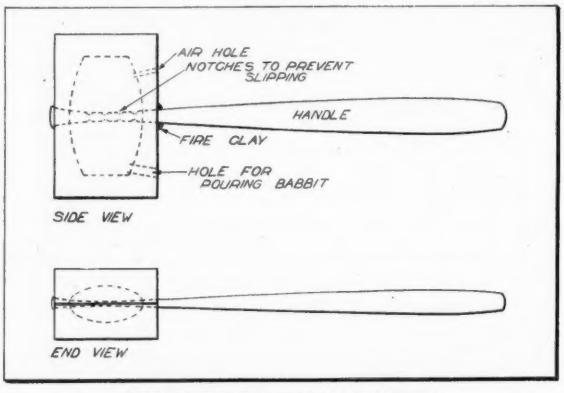
By dropping the pressure until the engine exhausts at about 5 lb. above atmospheric, economy will be promoted and the engine run better.

Recently, a 24-in. suction valve cracked and was repaired as follows: A wooden crate was built around the valve and well braced. Cement, mixed 1 part cement to 2 of sand, was put in the crate, or form, and after setting 48 hr., the form was removed. The valve is tight, and the cost of a new valve and delay saved.

A roof leaked around the rectangular flue, as shown in the illustration. Boards were nailed to the ceiling, extending to within ¼ in. of the flue. In this opening, asbestos wicking was calked and over the top of the roof above was spread a layer of cement in the proportions named above. This was 2 yr. ago and the roof is still tight. RECEIVER.

Making a Babbit Hammer

A RELIABLE way of making babbit hammers is by the use of a cast-iron mold as shown in the sketch. Notches



MOLD USED FOR BABBIT HAMMER

are made in handle to prevent it from slipping and eliminates wedging. FISHDAY.

Crowning a Flywheel

A SINGLE cylinder vertical gas engine of 18 hp. having 2 flywheels had been used in an auxiliary room, but on account of some changes it was to be moved to a different place where it could be used to run a line-shaft and also, at times, a generator.

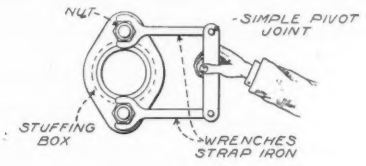
Only one flywheel was crowned and as the other was to be used, it was crowned in the following manner: A block of wood a little longer than half the flywheel diameter was stood on end in front of the wheel to be crowned, the engine was started and a piece of an emery wheel was held on the block and used to grind down the wheel face until a good crown was made.

The wheel was 4 ft. in diameter with about 4 or 4½-in. face and I believe the job took less than ½ day of one man's time. HAWLEY L. SCOTT.

Homemade Stuffing Box Wrench

MANY A piston rod has been ruined because of improperly tightened stuffing boxes. It is always so much easier to tighten the upper than the lower nut that the upper is most used and, as a result, the stuffing box is made to bind.

After witnessing an accident due to this cause some years ago, I made a special stuffing box wrench from sheet metal as shown in the sketch. By using this



WRENCH WHICH INSURES EVEN PRESSURE ON PACKING

wrench, both nuts are tightened an equal amount simultaneously. Binding becomes impossible.

The wrench, which I made out of ⅛-in. strap wrought iron, worked very well. A wrench for stuffing boxes of this kind usually need not be very strong.

N. G. NEAR.

Babbiting Small Boxes

IN BABBITING crankpin boxes, the first step is to turn a mandrel same size as the pin and wrap it once or twice with thin paper as in Fig. 1, and before taking out the boxes drop the wedge down to the bottom of the box and pry them apart as far as they will go and center punch them and use dividers as in Fig. 2 in order to get them the same distance apart when babbiting them, as in Fig. 3. Clamp the box in iron bars in order to get them square. A is the form of liner used to put

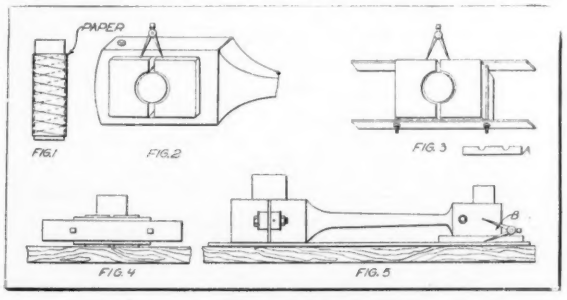


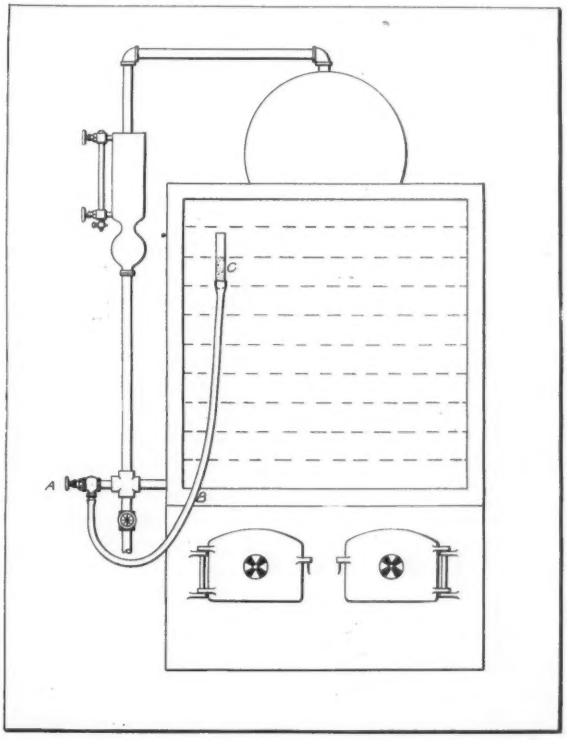
FIG. 1. MANDREL WRAPPED WITH PAPER
FIG. 2. SETTING DIVIDERS BEFORE REMOVING BRASSES
FIG. 3. SETTING BRASSES IN CLAMPS
FIG. 4. IN POSITION FOR POURING
FIG. 5. SQUARING BOXES FOR POURING WHEN ROD IS REMOVABLE

between boxes and mandrel so both sides can be poured at once, having 2 small holes cut in the liner through which babbit will run, and it is easily broken apart after it is babbited.

Figure 4 shows the box ready for pouring the babbit in it. If practicable, the rod should be taken out and placed upon a bench, as in Fig. 5. Find the center on the rod, using dividers, as at B, in order to get both ends the same height and there will be no trouble with the boxes after they are babbited if proper oil grooves are cut in them. A. L. JOHNSON.

Leakage Gage for Boilers

WE ALL have more or less trouble with leaks in water-tube boilers, and it is not always the leaks that bother so much as the trouble and time of finding them; that is, if they happen to be above the second row from the bottom. I had a case of this kind a few weeks ago and the firemen could not locate the leak, so I got a bushing from 1¼ to ½ in., put it in the cross on column at A, attached a ½-in. valve with close nipple, and to this a ½-in hose, B, slipped on a ½-in. nipple. On the end of the hose I put a gage glass, C, 12 in. long. To use this gage to find the leaks, you empty the boiler, take out the manhole plate; or open something to let air out



METHOD OF LOCATING LEAK

while filling the boiler; if the air is not let out, there will be a pressure built up and the gage will not work. As the boiler fills up the glass on the hose must be higher than the tubes, and, watching for the leak, when you see the water drop, shut off the water going into the boiler, and then take your gage glass on the hose and bring it down near the water leg, in front or rear of boiler, as the case may be, and as the water shows in the glass at that row of tubes on the level with it you will find the leak. In the sketch, the gage shows the water level or the leak in the second row from the top. W. A. JONES.

GRINDING ALUMINUM is easily accomplished by using ordinary machine oil as a lubricant. It has no effect on the grinding wheel, which will last longer when grinding aluminum in this way than when grinding cast iron.—The Gas Engine.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

A Big Grate at Light Load

In a laundry plant having a 100-hp. boiler, the power called for is comparatively small, except on one day in the week. Investigation shows that because of the excessive grate area, there is from 50 to 60 per cent loss of fuel during the rest of the week. Pocahontas coal is used, hand fired. It is not possible to bank the fire, because a 20-hp. load may be called for any time in 5 min.

Can anyone suggest a method for handling this plant so as to maintain economical combustion at all times? G. M. C.

Distilled Water on Shipboard

Is it possible that ocean-going steamers distill all the water they use, as stated by K. Watt in the Sept. 15 issue? I always had the idea that they had fresh water tanks aboard and used the evaporators only in case of emergency.

I would be greatly interested if some of the readers with marine experience would send in more about these distilling plants.

Would it not take a large proportion of all the boilers to furnish steam for evaporators large enough to distill sufficient water for a passenger liner? J. C. L.

Government Examination Questions

When taking the examination for the position of Master Electrician, Quartermaster Corps, 2 yr. ago, I was asked the following questions which I believe I answered correctly. Since then, however, I have had occasion to discuss these problems with several persons and find considerable difference of opinion, not so much as to the correctness of my answers as to the method used in securing them. I am, therefore, turning to Practical Engineer for aid and wish some of the readers would kindly work these problems out in detail for me.

The questions were put as follows:

What cylinder and piston rod sizes would you expect to find on a cross-compound engine developing 200 hp. at 250 r.p.m., working under a steam pressure of 125 lb. per sq. in. at the throttle and 26 in. of vacuum?

State amount of steam you would expect this engine to consume per indicated horsepower per hour.

What indicator springs would you use to take cards from this engine?

Draw type and size of cards you would expect to obtain from both cylinders of this engine when operating under full load. Show location of atmospheric line.

Assume the mean effective pressure for these cards and calculate the indicated horsepower of the engine. I. O. M.

Mass. Examination Questions on Steam Turbines

Give a comparison of an impulse and reaction turbine.

A. Impulse: Few stages, expansion in nozzles, large drop of pressure in stage, initial steam velocity is in general high (1000 to 4000 ft. per sec.), blade velocity 400 to 1200 ft. per sec., best efficiency when blade velocity is nearly ½ of initial velocity. Reaction—many stages: No nozzles, small drop in pressure in a stage, all steam velocities are low (300 to 600 ft. per sec.), blade velocities (200 to 400 ft. per sec), best efficiency when the blade velocities nearly equal the highest velocities of the steam.

2. Give 4 ways of governing. A. Throttling steam supply, varying the time of admission, cutting out nozzles, admitting steam from the boiler at various points along the direction of steam flow, called bypass governing, varying time of admission called blast governing.

3. How is it that there is no side thrust on a Curtis turbine? A. The steam enters and leaves the blades at the same angle.

4. What advantage has the relay system of governing over the direct? A. A large centrifugal force is needed to move the valve, unless they are carefully balanced with the direct, so the governor is not so sensitive. With the relay system the governor only gives the signal and the valves are moved by auxiliaries worked by hydraulic steam pressure.

5. What is the difference in the action of steam in the impulse and reaction types? A. Impulse: Steam does not expand in the blades. Reaction: Steam expands all through the turbine.

6. What is a stage in a Parsons turbine? A. A set of moving and a set of stationary blades.

7. What is a stage in a Curtis? A. It differs, as it may have more than 2 sets of wheels in a stage.

8. What are absolute and relative velocity? A. An absolute velocity of a body is its velocity with respect to immovable parts of the earth. Relative velocity of a body is its velocity with respect to points that are also moving.

9. What is the rotor on a Parsons turbine? A. The shaft with the attached bucket wheels.

10. In what type do impulse and reaction take place? A. Parsons.

11. How much is the clearance between the blades on a Curtis turbine and Parsons? A. Curtis, 1/32 to 1/16 in.; Parsons, ⅛ to ½ in.

12. How do they reduce the speed of a bucket wheel? A. By using more than one set of bucket wheels, each set doing its own share of work.

13. How many types of turbine are there? A. Two: Impulse and reaction.

14. How many stages has a Terry turbine? A. Non-condensing has one, condensing has two.

15. What does the step bearing on a vertical Curtis run on? A. Oil or water.

16. How many ways of governing a Curtis are there? A. Two: Electrical and hydraulic.

17. Why is it that the pressure on top of the bucket wheels on a vertical Curtis turbine does not push the wheel cup shape? A. Any pressure that is on top of the wheel is also under, consequently it is balanced.

18. How is the steam expanded in a Curtis? A. In expansion nozzles, then going from one set of blades to another.

19. How does the governor get its motion on the Westinghouse-Parsons? A. From the worm on end of shaft driving the governor spindle.

20. How are the stuffing-boxes made? A. So that the packing or carbon rings will not touch the shaft, and a small passage for stopping leaky steam is very narrow.

21. How many powers of control has it? A. Three: the plain throttling, admission in puffs, and variation of nozzle opening.

22. What kind of governor is used on the "De Laval?" A. Throttling.

23. What kind of governor is used on the Westinghouse-Parsons? A. Puff.

24. What part of a turbine requires most attention? A. The governor and valves, as they are liable to stick shut due to no lubrication, close fit, too much expansion.

25. How many governors are used on a turbine? A. Generally two, one to regulate the speed and one for emergency as a valve sticks open when load is thrown off.

26. How is a controlling valve operated? A. Electrically and hydraulically by means of a pilot valve, which operates the main valve, otherwise the governor would have to be too large. The governors are of inertia type doubledeck form.

27. What is a compound impulse turbine? A. Where 2 or more groups of wheels and guides are arranged in separate compartments, each group being called a stage. The exhaust from one stage passes through nozzles to the next wheel, and so on, according to the number of stages used.

28. What is the object of a stage turbine? A. To produce a gradual fall in pressure.

29. What kind is the De Laval? A. Simple impulse.

30. Where are the buckets in the De Laval? A. In the periphery these are milled buckets or vanes.

31. How is the steam delivered in a De Laval? A. Against the buckets at a high velocity through nozzles ranging from 1 to 8 in number.

32. How does the steam act on a De Laval? A. The expansion of this steam, which produces this high velocity, takes place in the diverging conical nozzles of each jet, the tops being so proportioned as to give the steam the proper expansion to cause it to attain its greatest velocity as it reaches the values of the wheel. The initial pressure is gradually reduced at each increasing section of the nozzle to a final pressure equal to that of the atmosphere, or of the condenser. In this case, all the available heat energy of the steam is transformed into kinetic energy. W. N. L.

Operating Ice Machines

KINDLY TELL me the general procedure in starting and stopping an ice machine.

2. How do you calculate the horsepower of a steam engine? SUBSCRIBER.

ANSWERS

IN STARTING an ice machine, the first thing is to be sure that the discharge valves between the compressor and the condenser are wide open. If a steam driven machine, the discharge valve should be opened even before warming up the engine. Let the machine run slow while opening the suction valve to guard against accident caused by liquid in the suction line. After the suction valve is wide open and everything clear, bring the machine up to speed.

It is always best to turn the water on the condenser before starting the machine, but this is not absolutely necessary. If the weather is cold, the water can be left shut off till the machine has run a short time and the condenser pressure is at its usual point. The only objection to this is that something may cause the engineer to forget it and perhaps cause an accident.

After the machine is in operation and the water running over the condenser, the back pressure gage is watched till it shows the desired pressure. Then the expansion valve is opened the required amount.

When shutting down the ice machine, the first thing to do is to pump down the system by shutting the main liquid valve at the receiver or shutting the expansion valves. Let the machine run till the back pressure gage shows a little above zero, then shut down and close the suction and discharge valves. Some engineers do not shut the discharge valve at all except when doing repairs on the compressor or packing the rod. It is best always to shut it, as this will prevent liquid from collecting in the cylinder if the compressor valves leak. Shut the water off the condenser last.

2. To figure the horsepower of an engine, it is first necessary to take indicator diagrams or draw a theoretical diagram so that the mean effective pressure on the piston can be obtained. Multiply the mean effective pressure by the area of the piston in square inches, by the length of the stroke in feet and by the number of strokes per minute. Divide by 33,000 and the result is the horsepower.

The friction load is figured separately from a friction card taken at no load and is subtracted from the full load horsepower. The result is the horsepower required to do the effective work. Friction may be estimated at 10 per cent of the rated horsepower.

A. G. SOLOMON.

Zinc As a Scale Preventive

I OFTEN READ of engineers using zinc in steam boilers to prevent hard scale forming on the plates and tubes. I would like to know what success, if any, they had in its use, and in what manner it is to be applied.

J. A. S.

A. Using zinc to prevent the formation of boiler scale is really an electrical treatment. There is a difference in voltage between the zinc and the iron of the shell of the boiler, which produces electrical currents of very low voltage through the water of the boiler, and

thus causes a slight electrolysis. This does not take much metal from the boiler shell, but takes sufficient to keep it cleaned off, and to prevent the attachment of scale to the boiler shell. From the very nature of the action, unless the process is watched carefully and the boiler frequently inspected, there is likely to be local pitting and corrosion to some extent, particularly along the seams.

The method of using this treatment is simply to suspend plates of zinc in the water in the boiler. These are usually suspended from the stays in the upper part of the boiler, and the electrical process goes on without further attention.

In cases where there is not much scale-forming material in the water, this has seemed to give good results; but where the scale problem is serious, we do not believe it will be effective. A. L. R.

Compound Engine Operation

A TANDEM COMPOUND engine has a receiver twice the volume of the high-pressure cylinder. The low-pressure cylinder has a volume 4 times greater than the high-pressure cylinder. The terminal pressure of the high-pressure cylinder is 30 lb. Steam is cut off at ¼ stroke in both cylinders.

What is the initial pressure in the low-pressure cylinder?

2. Why does not the pressure in the receiver continue to rise as it does when starting up the engine?

3. Why does shortening the cutoff in the low-pressure cylinder throw a greater load on that cylinder?

SUBSCRIBER.

ANSWERS

THERE ARE many things regarding the operating conditions of compound engines upon which eminent authorities differ widely, as the conditions under which each investigator obtained his data differed to a great extent. The results obtained by these several authorities are all different along the same subject, so that the amateur in conducting experiments along similar lines is apt to become discouraged when he finds that his results are different from those in the reference book.

The writer has had occasion to indicate a number of compound engines under a great variety of operating conditions, and has found that under conditions similar to those contained in the data submitted, under good conditions the terminal pressure in the high-pressure cylinder will be about 2 lb. above receiver pressure and the initial pressure in the low-pressure cylinder will be about 1 lb. below that. And here, again, due allowance must be made for heat losses between the 2 cylinders, for the drop will be greater where no insulating material is used on the receiver and pipes. Sometimes the terminal pressure in the high-pressure cylinder will be at or below the receiver pressure, as can be seen in the expansion line on the indicator card running out into the receiver pressure line, or slightly below it. This loop is negative work, and to all intents and purposes is a drag on the engine, and in tracing a diagram with a planimeter, the instrument automatically makes the deduction; but if you use ordinates, be careful to deduct the length of the ordinates in the loop from the length of those in the main part of the diagram.

2. The receiver is the boiler for the low-pressure cylinder and if the pressure were to rise in it continually after the engine has arrived at its predetermined speed, this would throw a gradually increasing proportion of the load on the low-pressure cylinder, thus reducing the load carried by the high-pressure cylinder, and this in turn would reduce the quantity of steam passing to the low-pressure cylinder. Thus it is that in a well designed engine, these conditions are taken care of automatically by the governor.

The earlier compound engines with adjustable cutoff had a hand-adjusted cutoff on the low-pressure cylinder, leaving the regulation to be taken care of on the high-pressure cylinder alone. This arrangement is not to be commended unless the load is quite constant, under which conditions it is still used.

3. Shortening the cutoff increases the ratio of expansion in the cylinder, thus admitting a slightly smaller quantity of steam. This, in turn, increases the initial pressure which increases with the receiver pressure. To be sure, it increases the resistance to the high-pressure cylinder; but this increased pressure is also acting positively on the larger area of the low-pressure piston.

In designing a compound engine, no matter whether of the 2, 3 or 4-cylinder combination, the low-pressure cylinder is first proportioned to carry the entire load within the range of absolute pressure available. This done, the load is divided into as many equal parts (or as near as possible) as there are cylinders. So you see, as a matter of fact, theoretically, it would be possible so to shorten the low-pressure cutoff that the initial pressure in it would be equal to boiler pressure (approximately) and while it would be carrying the entire load, the high pressure piston would be simply traveling back and forth with an equal pressure on both sides of it which would be boiler pressure, or the same as the initial pressure in the low-pressure cylinder; however, to prevent any abnormal rise in pressure in the receiver and low-pressure cylinder, the receiver is provided with a relief valve of such proportions as to take care of all the excess steam to which it could be subjected.

G. H. WALLACE.

Proper Location of Expansion Valves

WE HAVE a 5-ton direct expansion refrigerating machine the compressor of which is run by a 10-hp. electric motor. At present we have this machine located quite close to the coolers, but intend to move it to the power house, a distance of approximately 360 ft. from the coolers and with the piping carried the greater part of the way through a tunnel.

We run the machine about 8 months out of the year at an average of about 5 hr. a day, during which time we lower the temperature of the coolers to 32 to 34 deg. F. and freeze 9 60-lb. cakes of ice. We also have an additional cooler located between the first mentioned and the power house. The liquid line is of ½-in. piping while the suction line is of 1¼-in. pipe.

Where would you advise placing the expansion valves—close to the cooler or at the machines in the power house?

The sizes of the various coolers are as follows: Number 1, 19 ft. 4 in. long, 8 ft. 4 in. wide and 8 ft. 6 in.

high; number 2, 19 ft. long, 6 ft. 10 in. wide and 8 ft. 6 in. high; number 3, 16 ft. long, 6 ft. wide and 8 ft. 6 in. high; number 4, 11 ft. 6 in. long, 5 ft. 8 in. wide and 9 ft. high. J. W.

A. Definite information as to the new cooler to be added cannot be given unless we know the size of the room, the temperature at which it is to be held and the amount and kind of material put in.

If the room called No. 4 means the new cooler, then the difference in the length of time that the machine has to run will be increased less than an hour, providing that the room is carried at from 32 to 34 deg. F., same as the others.

Moving the compressor a distance of 360 ft. from the coolers is not to be recommended, if it were possible to keep it close to its work.

The ½-in. liquid line is large enough, but better results will be obtained if the suction line is increased to 2 in. This added area will help to reduce the friction in the 360-ft. pull. The liquid and suction lines should be placed right together and insulated with the best insulating material obtainable. The manufacturers of such material will be able to tell exactly what is the best for your special condition. Run the lines straight as possible with a very slight fall toward the compressor, so that no pockets will be formed in the suction lines.

Do not place the expansion valves any other place except right at the coils, or the ammonia which reaches the coils will have little heat-absorbing power when it gets there. A. G. Solomon.

Boiler Questions and Answers

What is a valve spindle?

2. What is the combustion chamber of a boiler and what is its function?

3. What danger exists between pressure and lift of a safety valve? Why?

4. What does the indicator card show as it comes from the indicator?

5. What is an exhaust pipe to a boiler? Where is it? What is meant by it?

6. How much space is allowed over the bridge wall of a return tubular boiler?

7. What effect would the breaking of a governor spring have on an engine?

8. How is the required tube or flue area in a boiler determined?

9. In both water and fire-tube boilers, how far below the first gage cock is the fire line?

10. What is combustion?

11. What is perfect combustion? W. C. D.

Answers

The valve spindle is only found on certain types of valves, and is practically the same as a valve stem. It is used simply to guide the valve, so that it will rise and fall without tipping, as the tipping might get it stuck in the valve chamber, or it might let it come back on to the seat at an angle, so that it would not seat tight.

2. The combustion chamber in a boiler is a space beyond the firebox, provided to give time for completing the burning of the gases. As they come from the firebox, these gases usually have a good deal of carbon monoxide and free oxygen, and if these are thoroughly mixed and allowed a little time, at high temperature, before they come in contact with the boiler tubes, the carbon monoxide will be burned to carbon dioxide, giving up 3 times as much heat as it would if the combustion were not complete.

3. In a pop safety valve, the greater the pressure before the valve blows, the higher will be the lift. We do not see that there is any danger in this relation, except that in a pop safety valve, if the spring be made too short or wound too close, there may not be opportunity for the valve to lift as high as it should; but this condition would never exist in any commercial form of safety valve.

4. The indicator card as it comes from the indicator shows the relation of the back pressure line to the atmospheric line, and by its shape indicates the valve action. The area of the diagram shows, also, in a general way, how much load the engine is carrying, but, of course, this cannot be found accurately without laying out the card and finding the mean effective pressure.

5. We have never known of any pipe from a boiler being called the "exhaust" pipe. The steam pipe comes from the top of the boiler, and carries the steam away for whatever use may be made of it. The blowoff pipe comes from the lowest point in the boiler, and is used for carrying out the dirty water and deposits from the bottom of the boiler. In a return tubular boiler, this usually comes from the bottom of the shell, near the back end, which is set lower than the front end. In a water-tube boiler, it comes from the mud drum, which is the lowest point of the boiler at the back end, provided especially to permit dirt and foreign matter to settle out.

6. The space above the bridge wall depends entirely on the size of the boiler. The common rule is, to make the area above the bridge wall 1/7 of the grate surface.

7. If the centrifugal spring of a governor breaks, the governor will fly to the extreme outer position, and in most modern engines, this will mean that the steam will be cut off entirely, so that the engine will stop.

8. The area for the flues, or tubes, in a boiler is usually made ⅛ the grate area.

9. We presume that you mean, how far below the bottom gage cock should be the water line? You will find this answered on pages 707 and 708 of the July 15 issue. For the return tubular boiler, the lowest allowable water line is usually 3 in. above the top tube. In the water-tube boiler, the same thing is true, although the water line is in the upper header, not in the tubes.

10. Combustion is the combination of some element with oxygen. In the boiler furnace, it is a combination of carbon and some hydrogen with oxygen, forming carbon monoxide or carbon dioxide, and water. In the slow combustion of iron in the atmosphere, we form iron oxide, or iron rust. If we burn sulphur, we form sulphur dioxide.

11. Perfect combustion means, when every particle of the second element, such as carbon, or iron, or sulphur, has taken up its proper proportion of oxygen. In the case of carbon, this would be when all the carbon has formed carbon dioxide. A. L. R.

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Pointers on Economy

To one who has had occasion to visit many power stations, it is surprising how lax many chief engineers appear to be regarding the care and proper storage of supplies. When a new bale of waste is received, it will be placed under a work bench, in the pipe shop, or in some other place readily accessible to all. Then, whether the former supply is all used or not, whoever cares to do so, will open the bale and take as much as will conveniently fill the pockets of his overalls. In this way, the waste will go. Where it has gone, no one knows, and as a result, many times 2 bales of waste are used where one might have served the purpose.

Another source of loss in the majority of plants is in the oil and grease supply. Here, also, the oilers, wipers and those not carrying any direct responsibility, are given free rein, so that many gallons of oil and pounds of grease are wasted.

This same state of affairs exists with all the supplies, such as the various packings, pipe fittings and valves.

Men in charge of these plants do not realize that due to such haphazard methods, many hundreds of dollars are being charged up against operation, sending the unit cost of generation way above the point it rightfully belongs.

In order to avoid these financial drains, every plant, regardless of its size, should have some form of stock room for the safekeeping of its supplies, access to which should be given to but one man, namely, the engineer on duty. In this way, much waste can be avoided, as the men working around the plant will thus be given just the proper quantity of supplies and no more.

As a further aid toward economical operation, it might be suggested to maintain a record of all stock received, from whom received and its price, together with a record of stock used, where used and its price. By doing so, the operator will be enabled not only to keep a perpetual inventory of his stock, but also to determine the exact cost of repairs, renewals and upkeep.

The Other Fellow's Plant

In all lines of endeavor it is found that the greater the amount of personal intercourse existing between those engaged in similar vocations the greater are the benefits enjoyed by all concerned. New ideas and discoveries when retained by their originators are of little value and it is only due to the exchange of such ideas and the availability of such discoveries that not only the individual but also the public profits and progresses.

It is only by the continual observation of his fellow worker's activities that an engineer can ever hope to succeed, and one of the most ready means at his disposal for accomplishing this is to spend more or less time visiting the various power plants about the country. This, however, takes him from his work—a thing the plant operator can not, as a rule, afford — and on those days when his time is his own, he finds it difficult or impossible to gain access to the plants he desires to visit. And should he, at times, be given a short vacation, he feels, and rightly so, that he owes it to himself and family to break away from his work at least for a short time.

How, then, can he acquaint himself with the latest developments in engineering? How can he find out how the other fellow does things with which he himself is having difficulty or which he ought to know in order to improve and render himself able to operate his plant more efficiently and thereby prepare himself for promotion?

According to the policies of the editorial department of Practical Engineer, the first few pages of every issue are devoted to detailed descriptions of the most recently constructed or reconstructed power plants, and generating systems. Realizing the inability of the engineer to visit such new and interesting installations, they are brought to him.

And, many times, even though the individual be possessed of the available time to make such trips of inspection, it will be found that where the management of a plant has consented to admit a representative of Practical Engineer, others may be denied such privileges.

News Notes

PERRY BARKER, fuel engineer, announces the opening of offices and laboratories in the Oliver Building, 141 Milk St., Boston.

THE STOCKHOLDERS of The Belting Company at a recent meeting unanimously voted to change the name from "The Belting Company of Ohio" to "The Cleveland Fabric Belting Company," and the brand "Old Hickory" to "Clefabco."

IN THE College of Engineering of the University of Illinois, additions to the staff were made, beginning Sept. 1, as follows: W. M. Hekking, as Associate in Free-Hand Drawing; A. V. Bleininger, as Head of the Department of Ceramic Engineering; C. V. Burger, Instructor in Drawing; L. C. Dillenback, Instructor in Architectural Design; C. S. Sale, Assistant to the Director of the Engineering Experiment Station; C. S. Fazel, Assistant in Physics.

As Research Fellows in the Engineering Experiment Station, the following were appointed: H. R. Fritz, Electrical Engineering; F. A. Kirkpatrick, Ceramic Engineering; L. J. Larson, Theoretical and Applied Mechanics; W. A. Manuel, Chemistry; L. A. Mylius, Mining Engineering; B. R. Ordonez, Railway Engineering; S. F. Tanabe, Physics; R. L. Templin, Theoretical and Applied Mechanics; C. Weiss, Civil Engineering.

AWARDS AT THE Panama-Pacific International Exposition are made on the basis of a scale of markings, 100 being used to indicate perfection. As between exhibits in the same class, that receiving the highest marking is awarded the Grand Prize, of which there is but one in each class. Exhibits having markings between 95 and 100 receive a Medal of Honor; from 85 to 94, a Gold Medal; 75 to 84, a Silver Medal; 60 to 74, a Bronze Medal. Special award of gold medal in each department may be recommended for the best, most complete and most attractive installation, and a diploma of Honorable Mention without medal may be awarded for special reasons. Also, an award may be made to an inventor, designer or artisan who is still living and has, in the judgment of the jury of award, shown more than ordinary skill in connection with the design or preparation of the exhibit or the articles on exhibit.

In this connection, the United States Steel Corporation and its subsidiary companies has received a remarkable list of awards, including several Grand Prizes, many Gold Medals and a large number of Medals of Honor in different departments. The Grand Prizes awarded are, first, for a comprehensive, educational exhibit of the steel industry; second, for the exhibit of safety, relief, welfare, housing and sanitation activities; third, to the Carnegie Steel Co., for general excellence of its finished and semi-finished, furnace, mill and shop products and by-products; fourth, to the Illinois Steel Co., for a like reason; fifth, to the Tennessee Coal, Iron & Railroad Co., for a like reason; sixth, to the Lorain Steel Co., for excellence of its girder, groove, guard and high tee rails and track work products; seventh, to the American Bridge Co., for general excellence in design and workmanship of its fabricated steel products; eighth, to the American Sheet & Tin Plate Co., for general excellence of its sheet and tin mill products; ninth, to the American Steel & Wire Co., for general excellence of iron, steel and copper, wire mill products; tenth, to the National Tube Co., for excellence of its tubular products and fittings; eleventh, to the Universal Portland Cement Co., for excellence of its Universal Portland cement.

The special materials in the exhibit of the National Tube Co. which won the Grand Prize were National oil well casings, tubing, drill and drive pipe, line pipe and lead joint pipe, manufactured in 40-ft. length; spellerized pipe and boiler tubes, and steel poles, National protective coating, Kewanee unions, valves and fittings, and Shelby seamless steel tubing, including special alloy steel tubing, boiler tubes, cylinders, steam pipe, drill pipe, mechanical tubing and trolley poles.

THE DETROIT ENGINEERING Society has sent out advance notices of a massmeeting for Friday, October 15, at which Prof. Edward Orton, Jr., Dean of the Engineering Department of the Ohio State University, and manufacturer of Standard Pyrometric Cones, will read a paper entitled "Refractory Materials," discussing at some length the chemical reasons governing the selection of materials, the testing of refractories, plans for standardization of refractories, and uses of refractory materials, and to aid him in presenting the subject, will use lantern slides throughout the lecture.

IN THE REPORT of the exhibit held in connection with the Convention of the N. A. S. E. at Columbus, it was stated on page 938 of our October 1 issue, that H. D. Raymond was elected both vice president and secretary of the National Exhibitors' Association. This statement was in error, as Mr. Raymond holds the office of vice president only, J. W. Peterson, of the Richardson-Phenix Co., being elected to the office of secretary.

AT A MEETING held on Sept. 20, Foster Milliken, formerly president of Milliken Bros., Inc., a large structural steel and iron concern, which has works on Staten Island, was elected president of McNab & Harlin Mfg. Co.

This company has its main office at 55 John St., New York City, with large works at Paterson, N. J., where it has been engaged during the past 60 yr. in the manufacture of brass, iron and steel valves, cocks and fittings for steam, water and gas.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

The Deoleizer

IN A handbook recently issued by a large boiler manufacturing company, it is stated that, "If feed water is taken from a hot well the cylinder oil should be removed from it before it enters the boiler. If allowed to enter the boiler, it will deposit on the hot surfaces and these will inevitably be burned or blistered. The oil is also liable to cause heavy priming."

"London Engineering" says: The peculiarity of grease deposits in boilers is that their effect is out of all proportion to their thickness. It has been shown that scale of ⅛ in. thickness will raise the temperature of the furnace plates about 300 deg. F. As grease offers

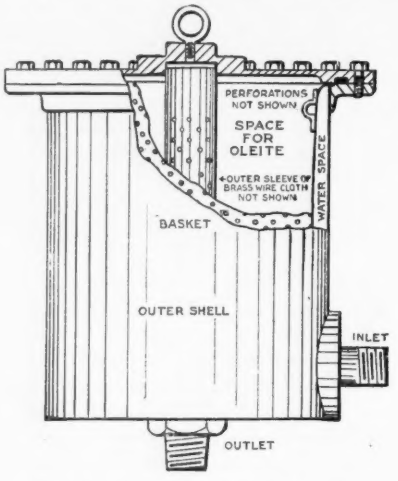


FIG. 1. SECTION OF CONTAINER

10 times more resistance to heat, it would seem that 0.0125 in. of it would have the same effect as ⅛ in. thickness of scale, but experience shows that the merest trace of grease, certainly less than 0.001 in. can cause far more injury than scale.

Where the cylinder oil forms an emulsion with the hot well water, its removal is difficult, if not impossible. An oil extractor should be placed in the exhaust pipe, but sometimes the amount of oil which passes through it is still too great to be allowed to enter the boiler.

As a general rule, cloudy return water contains dangerous quantities of oil and is not fit for boiler feed. Water must not only appear clean to the eye, but must also be free from the taste of oil before being used in the boilers.

One grain of oil per gallon means 1 lb. of oil fed to the boiler for every 7000 gal. of return condensation supplied to it. It is not uncommon to find the oil running as high as 10 grains per gallon. Assuming an average oil burden of 5 grains per gallon, and an evaporative duty of 30 lb. of water per hour per boiler horsepower, it follows that a 100-hp. boiler will accumulate over 2½ lb. of oil in a 10-hr. run, or 66 lb. per month.

Animal oils which quickly burn onto the plates and tubes have been largely discarded in favor of mineral oils, which are less likely to do damage.

Removal of oil from an emulsion has proved to be an obstinate engineering problem, as once suspended in water in microscopic, isolated particles, it refuses to yield to any form of mechanical filtration.

The purpose of the Deoleizer is to De-oil-ize, to take out oil. This name was adopted by the manufacturer as a self-descriptive term and as a trade mark.

The Deoleizer depends upon the affinity for oil of a certain newly discovered material, an affinity analogous to that of dry cement for water. This material is registered under the trade mark Oleite.

In appearance, Oleite resembles granulated charcoal, or old-fashioned black gunpowder. That it is neither, however, is evident from the fact that the process of manufacture involves calcining at a red heat in the presence of oxygen. It is strictly mineral in its nature and substantially indestructible.

The mechanism of the Deoleizer was designed from experimental data, mainly with a view to accessibility in cleaning, avoidance of possible "short circuits," efficiency per unit of surface, easy disconnection and similar practical points. The action, however, is dependent solely upon the inherent nature of the Oleite itself.

The deposition of oil is substantially as effective within the body of the material as on the surface. When the Deoleizer is emptied for renewal it is not merely the surface, but the entire body of material that is removed.

When the Oleite is clogged it can be recovered and used over again an indefinite number of times by merely emptying the basket into a steel tray and burning off the oil at a red heat in the boiler furnace or wherever else convenient.

The Deoleizer body is, therefore, merely a container for the material, consisting of an outer shell with a removable cover. Inside the shell is suspended a sheet steel basket, thickly perforated on the sides, but not at the bottom, and fitting down closely on a flange so as to be water-tight, while easy to lift out and dump.

The incoming connection is in the side of the shell and the oily water surrounds the entire area of the basket. After passing through the Oleite, the outlet is through a perforated brass pipe with a central bottom connection, which is covered with a sleeve of fine brass wire cloth, 25 mesh, to prevent any of the Oleite being drawn through into the pumps.

The Deoleizer is now being installed in 4 sizes, according to the conditions of service in the plant. If the plant shuts down at night it is only necessary to install a single Deoleizer. It only takes 20 to 30 min. to open up, empty, refill and close the container, and this is done only once in 2 weeks so there is ample time to empty and refill without the necessity of a bypass.

When the flow of return water is continuous throughout the 24 hr., it is often desirable to set the Deoleizers in pairs as shown in Fig. 2. These are operated alternately by means of a 3-way cock, the pressure gage being set in the main line in the position shown. Slight rise of pressure above normal indicates that refilling is required.

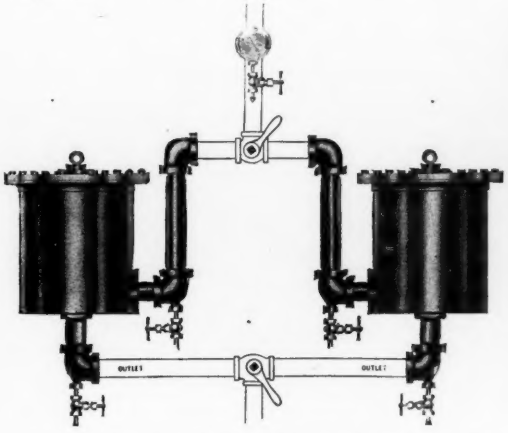


FIG. 2. THE DEOLEIZER CONNECTED IN PAIRS

In new plants where the volume of returns cannot be determined in advance or is liable to increase, the Deoleizers are set in battery so that others can be added from time to time if necessary.

The Deolizer is manufactured, sold and installed by William Andrews, Inc., 120 Liberty St., New York.

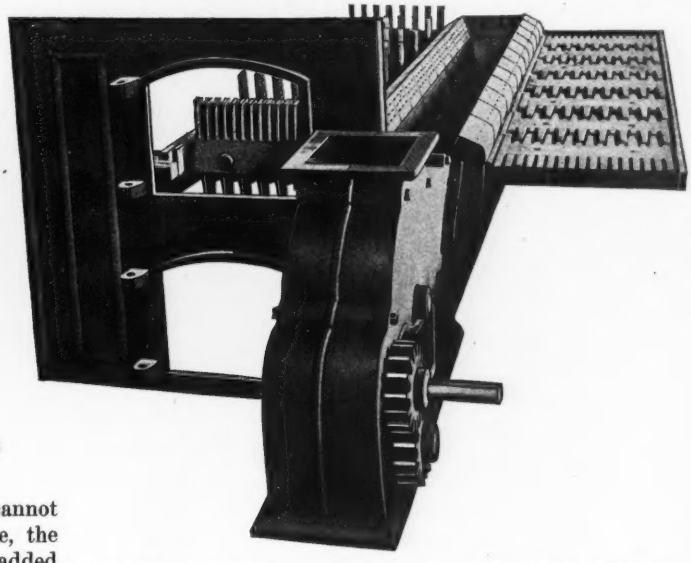
The Armstrong Underfeed Stoker

IN the Armstrong underfeed stoker, many difficulties which have been encountered in the operation of underfeed stokers have been overcome. Its principal new feature is the use of hollow blast shaking grates on each side of the horizontal retort, enabling the completion of combustion, under forced or natural draft, after the fuel has rolled out of the retort and the cleaning of the fires without the use of slice bars, pokers or hoes, also preventing the formation of clinkers over the grates. There are other features in the details of construction which adapt it to use under any type of boiler, making it simple to operate, efficient and reliable.

Coal is fed into a hopper over an oscillating quadrant which forces the coal in 10-lb. lots to a horizontal retort which extends to the rear of the furnace. In the bottom of the retort is an oscillating shaft to which are attached pushers that carry the fuel toward the bridge wall, forcing it up and over the edge of the retort its full length.

Surrounding the retort is a wind box with openings to receive the hollow trunnions of the grate bars and slots running lengthwise of the retort on both sides near the upper edges admit air into the thick bed of coking and burning fuel over the retort. As the fuel passes over the edges of the retort, it meets small blasts of air from the wind box coming through diagonal holes and passes to the grates where combustion is completed.

As previously stated, the grate bars are of the hollow blast shaking and dumping type, the air being furnished through hollow trunnions set into the wind box. Covering the hollow part of the grate bar is a dead plate in which are drilled small holes at a diagonal angle to the surface, which prevents the formation of holes in the



VIEW OF ARMSTRONG UNDERFEED STOKER SHOWING SPECIAL FEATURES

fuel bed. Grooves are also made in the edge of the dead plate which forces air out between the prongs of the grate bar, keeping them cool as well as supplying air needed for combustion.

The shaking and dumping features of the grates allow the cleaning of the fire without interfering with the operation of the boiler, and the cool grate surface prevents the formation of clinkers. Coal is fed into the retort at such a rate that the fuel which reaches the grates is largely coke which is there burned to ash and then falls through the grate bars to the ash pit or accumulates on the underside of the fuel bed where it has no chance to fuse with the burning fuel. Occasional shaking of the grates, however, is sufficient to remove the accumulation, keeping the fire clean. There is no interference with the falling of the ash through the grate, as the air under pressure is admitted through the hollow grates, while the ash pit is under atmospheric pressure, the ash-pit doors remaining open during operation.

If it is desired, the forced draft can be cut off the grate section of the furnace by sliding dampers which cover or uncover the openings from the windbox into the grate bar trunnions. In case of failure of the draft fan, the side grates can be fed by hand or through the retort as usual, combustion taking place under natural

draft conditions, thus getting a working grate surface equal to about 4/5 the entire grate surface of the stoker. This feature is also of advantage when starting a fire in the furnace, as it allows the starting of the fire without the necessity of forced draft.

This stoker is a new product of the Armstrong Mfg. Co., of Springfield, O., and is adaptable to any size or type of boiler and occupies a space of 28 in. in front of the boiler setting.

A Monster Relief Valve

HEREWITH is illustrated a 42-in. atmospheric relief valve, which has recently been furnished to the Commonwealth Edison Co., by the Edward Valve & Mfg. Co., for use in the atmospheric exhaust line of a new 30,000-kw. unit installed at the Northwest Station, Chicago.

In principle, the action is the same as for an ordinary relief valve of the horizontal type. The valve is shown vertical in the photograph, because of difficulty in placing it when the photograph was taken, but it is to be installed on a horizontal run.

FIG. 1. VIEW OF 42-IN. ATMOSPHERIC RELIEF VALVE

From the sectional cut it will be seen that all rubbing surfaces are bronze lined and the dashpot is provided with a bypass opening, so that the rapidity of opening and closing of the valve can be very closely regulated. The disk is built of steel, which avoids any possibility of giving way under sudden strain. A notable feature is the large area provided throughout the valve, which at no point is less than 100 per cent of the area of flange opening, and averages close to 110 per cent. The valve weighs approximately 6.5 tons, and has general dimensions as shown on the sectional view.

Barrett Gaspowrule

THIS rule, which works on the same general principle as the ordinary slide rule, has been developed from the results of a great number of gasoline engine tests and consists of an aluminum body and slide, the upper scale of the former being provided with graduations representing the bore of the engine with values ranging from 4 to 16 in.; the graduations on the lower scale are from 5 to 92 and represent the brake horsepower. The upper and lower scales on the slide bear graduations for the stroke in inches and the number of revolutions per minute.

By placing the stroke on the slide against the bore above, the approximate brake horsepower may be found under the specified number of revolutions per minute. Results obtained are, of course, not absolutely accurate, but the use of the rule furnishes a ready means of comparing the various sizes of engines relative to their bore, stroke and speed.

The rule may be used in connection with 4-cycle gas and gasoline engines and is also said to work out quite nicely for 2-cycle semi-Diesel oil engines. The Gaspowrule may be obtained by sending 75 cents to D. O. Barrett, Lima, O.

Book Reviews

STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS; 1984 pages, illustrated; New York, 1915; fourth edition. Price, $5.

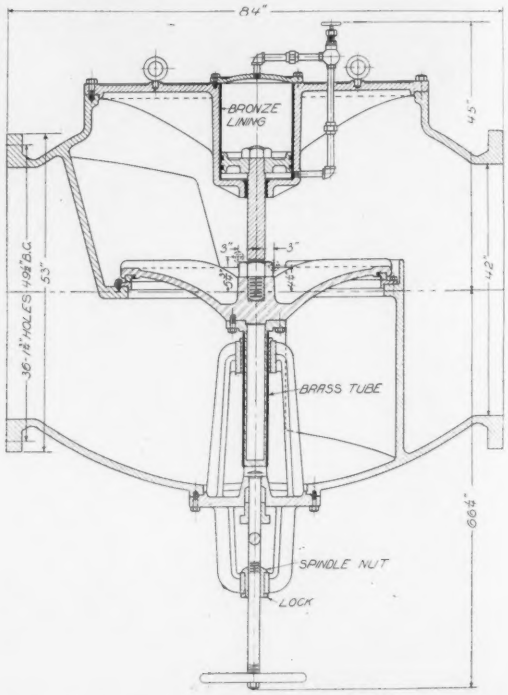


FIG. 2. SECTIONAL VIEW OF LARGE RELIEF VALVE

Among the new features in the makeup of this work of reference are the consistent use of subheads throughout each section and the grouping of these on each title page, the addition of bibliographies at the end of each section or subsection and the insertion of references.

Sections 1 to 5 inclusive cover the same general grounds as in the third edition, but have been almost completely rewritten and considerably extended.

Sections 6 to 9 inclusive embrace the same subjects as Sections 6 to 8 of the third edition, entirely rewritten.

Section 10 covers the same general subject matter as the corresponding section in the last edition, but is entirely rewritten and substantially enlarged.

Sections 11 and 12 cover the same ground as Section 11 of the third edition; Section 13 replaces Section

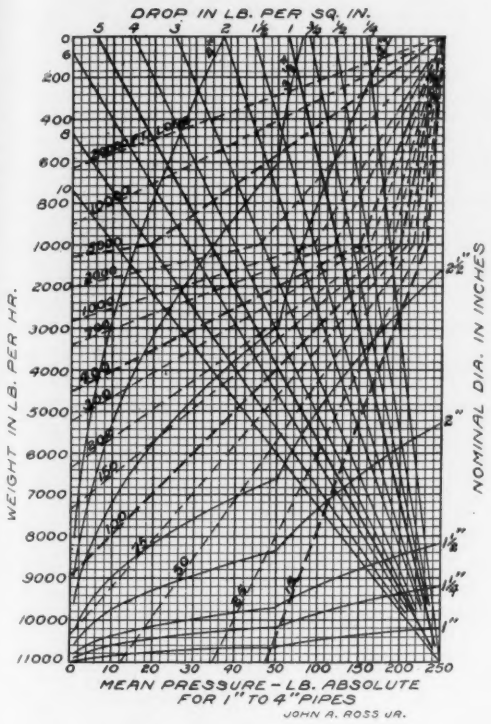
These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

XUM

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

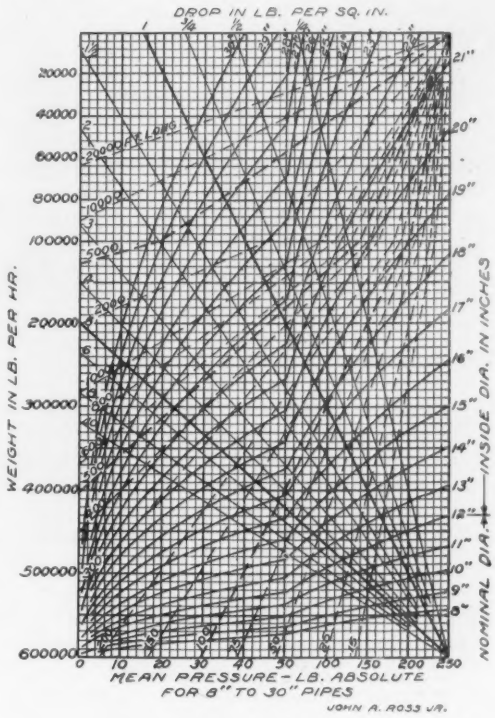
PRACTICAL ENGINEER

CHART I. STEAM FLOW IN SMALL PIPES



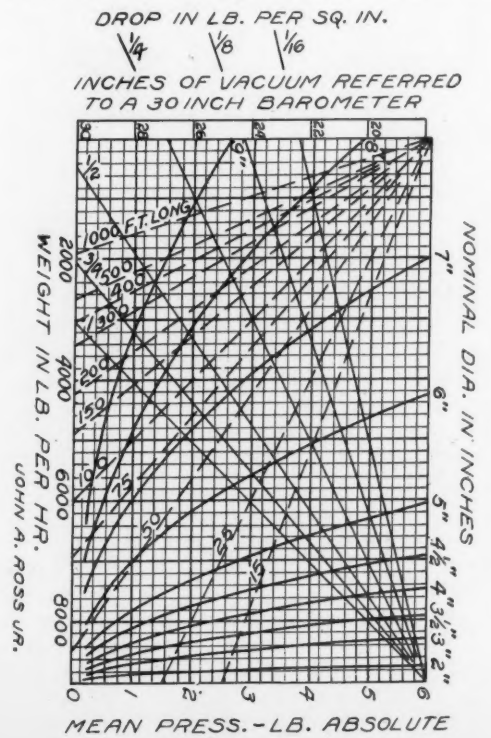
PRACTICAL ENGINEER

CHART III. STEAM FLOW IN LARGE PIPES


DROP IN LB. PER SQ. IN.
WEIGHT IN LB. PER HR.
NOMINAL DIA. — INSIDE DIA. IN INCHES
MEAN PRESSURE - LB. ABSOLUTE
FOR 8" TO 30" PIPES
JOHN A. ROSS JR.

PRACTICAL ENGINEER

CHART IV. EXHAUST STEAM FLOW IN SMALL PIPES


DROP IN LB. PER SQ. IN.
INCHES OF VACUUM REFERRED TO A 30 INCH BAROMETER
WEIGHT IN LB. PER HR.
NOMINAL DIA. IN INCHES
MEAN PRESS. - LB. ABSOLUTE
JOHN A. ROSS JR.

PRACTICAL ENGINEER

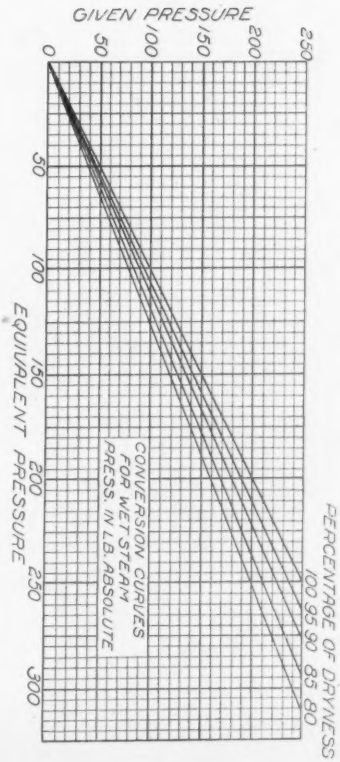


CHART V. EQUIVALENT PRESSURE OF WET STEAM

CHART VII. LENGTH OF PIPE EQUIVALENT TO FITTINGS

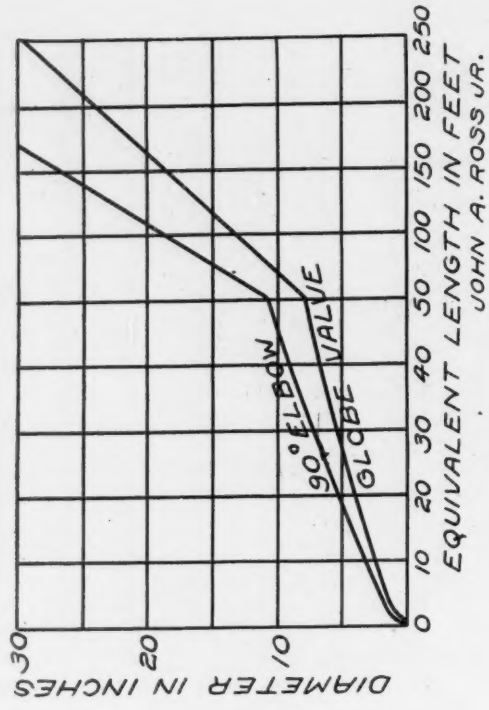


CHART II. STEAM FLOW IN MEDIUM PIPES

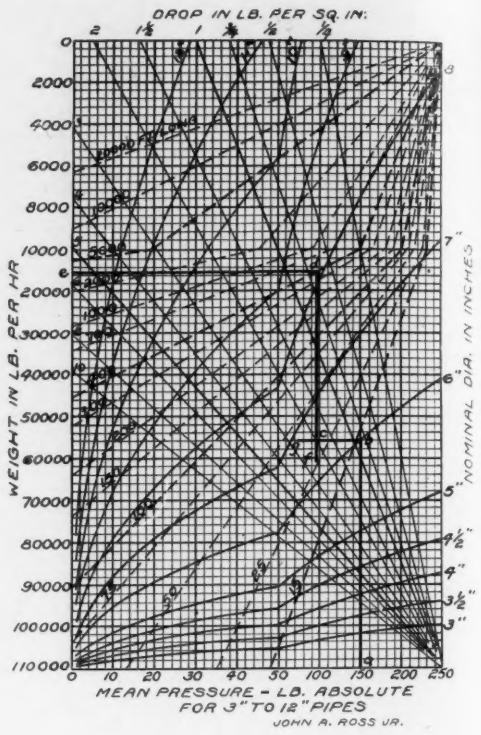


CHART VI. EQUIVALENT PRESSURES OF SUPERHEATED AND SATURATED STEAM

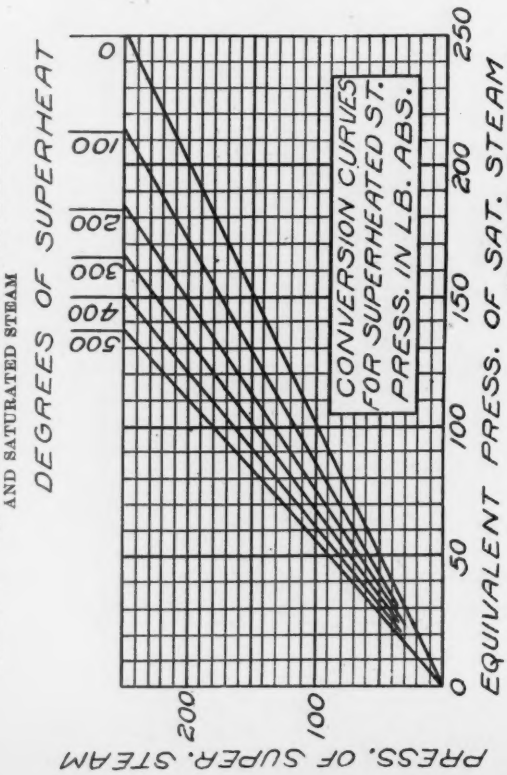
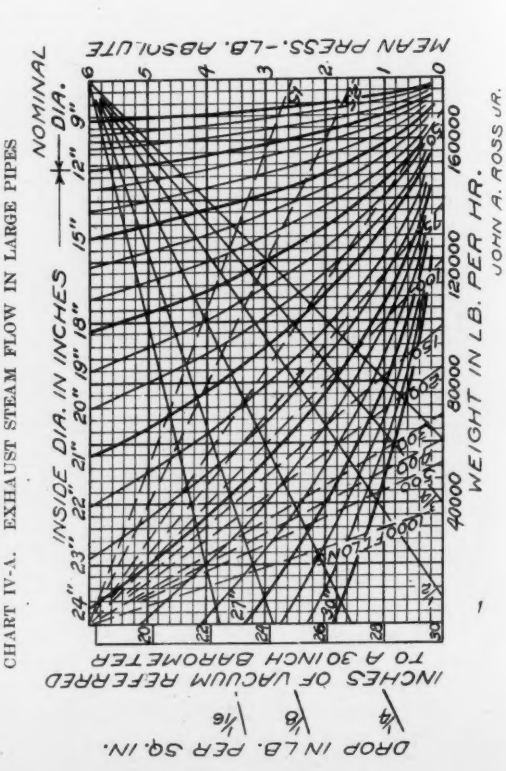

PRESS. OF SUPER. STEAM
200
100
0
0 50 100 150 200 250
EQUIVALENT PRESS. OF SAT. STEAM
JOHN A. ROSS JR.
DEGREES OF SUPERHEAT
0 100 200 300 400 500
CONVERSION CURVES FOR SUPERHEATED ST. PRESS. IN LB. ABS.

CHART IV-A. EXHAUST STEAM FLOW IN LARGE PIPES


DROP IN LB. PER SQ. IN.
¼ 1/8 1/16
INCHES OF VACUUM REFERRED TO A 30 INCH BAROMETER
MEAN PRESS.-LB. ABSOLUTE
6 5 4 3 2 1 0
NOMINAL INSIDE DIA. IN INCHES
9" 12" 15" 18" 20" 21" 22" 23" 24"
WEIGHT IN LB. PER HR.
160000 120000 80000 40000
JOHN A. ROSS JR.

18 of the previous edition, being entirely rewritten; Section 14 replaces Section 12 with new material; Section 15, Industrial Motor Applications, is a new section with entirely new subject matter.

Section 16 covers the ground of Section 13 in the third edition, but well revised. The new sections are 17 and 18, devoted to Electric Vehicles and Electric Ship Propulsion respectively.

Section 19 replaces Section 14 in the old edition, many portions being rewritten. Section 20 takes the place of Section 9 of the third edition, but with new material, and Section 21 replaces old Sections 15 and 16, also rewritten and altered somewhat in scope.

Section 22 takes the place of Section 17, old edition, with almost exclusively new material. Section 23, Mechanical Section, is new; Section 24 corresponds to Section 19 of the last edition; Section 25, General Engineering Economics and Central Station Economics, is entirely new.

VALVES AND VALVE GEARS, Vol. II, by F. DeR. Furman; 444 pages, 215 illustrations; New York, 1915; first edition. Price, $2.

This book, which is the second volume of a series entitled Valves and Valve Gears, treats on the valves and valve gears of practically all present-day types of gasoline, gas and oil engines, including those used in aeroplane work. By dividing this work into 2 volumes, it has been possible better to meet the requirements of varying courses of study, and the needs of those generally who are interested only in gasoline, gas or oil engines, thereby better enabling those who wish to study particular cases to do so without being encumbered with literature relating to any but the particular subject in question. The many illustrations used in connection with the text greatly add to the value of the book.

The subjects treated are General Characteristics of Internal Combustion Engines, Commercial Applications of Various Forms of Valves and Valve Gears to Gasoline Engines, Aeroplane Engines, The Gas Engine, Oil Engines, Diesel Oil Engines and Comparison of Prime Movers.

All in all, this book ought to appeal readily to those interested in the general subject of gasoline, gas and oil engines without regard to any particular type or make.

ELECTRICAL MEASUREMENTS AND METER TESTING, by D. P. Moreton. Chicago, 1915; 315 pages, 191 illustrations; first edition. Price, in limp cloth, $1; full leather, $1.50.

On account of the enactment of drastic legislation within the past decade relative to the proper maintenance and accurate operation of instruments used for the measurement of purchased electrical energy, that which may well be termed a new branch of electrical engineering, namely, meter engineering, has been created. Those men who are engaged in this line of work, but who do not enjoy the benefits of a well grounded course in electrical engineering, have been greatly handicapped in obtaining a full and proper understanding of their line of endeavor on account of the lack of up-to-date and reliable literature on the subject of practical electrical measurements and meter testing. It is to this class of persons and others interested in the subject, but not actively engaged in such work, that this book ought to appeal.

In the first 5 chapters, the author has attempted to give a clear and reasonably thorough discourse of the fundamental principles of electricity whereby the reader may be able to appreciate them in their practical application. Chapters I to V inclusive deal with Direct-Current Circuits, Magnetism, Electromagnetism, Electromagnetic Induction, Inductance and Its Measurement, Capacity and Its Measurement and the Alternating Current Circuit.

Chapters VI to XIII inclusive treat of electrical measurements, and the construction, operation and calibration of the instruments used in making such measurements.

The text is well illustrated throughout and in order to impress the most important facts upon the mind of the reader numerous examples and their solutions are given.

THE UNITED STATES BUREAU OF MINES has just issued Technical Paper 109, which deals with the chemical and physical properties of the natural gases used in 25 cities in the United States. In this paper, which gives the first comparative data of this kind ever published, the authors, G. A. Burrell and G. G. Oberfell, say:

The composition of the natural gas from 25 cities in the United States is shown. Five of the samples contain methane only as the combustible gas. The others contain, in addition to methane, higher members of the series of paraffin hydrocarbons. The heating values range from 735 to 1312 B.t.u. per cu. ft. at 0 deg. C., and 760 mm. pressure.

Natural gas in 2 different sands of the same field may vary materially in composition.

Some of the natural gas used in Texas has a heating value of about 740 B.t.u. per cu. ft. at 0 deg. C. and 760 mm. pressure.

The natural gas used in Pittsburgh, Columbus, Cleveland, Cincinnati, and many other places in the East is quite uniform in composition.

The explosive limits of mixtures of natural gas and air lie between about 5 per cent gas, low limit, and 11.50 per cent gas, high limit.

For many of the natural gases listed there is required about 10 cu. ft. of air per cubic foot of gas for complete combustion.

There is needed a very large amount of natural gas to suffocate men. As far as small animals (canaries) are concerned, the effect on them of mixtures of natural gas and air is principally due to the lowering of the oxygen content of the air by the diluting action of the gas.

According to Cady and McFarland and to Czako helium may be present in natural gases to the extent of from traces up to 1.84 per cent.

The ignition temperature of natural gases lies between about 550 and 750 deg. C.

The composition of the natural gas used in any one town may remain remarkably uniform for a long time.

Oxygen, carbon monoxide, hydrogen, and olefine hydrocarbons are not present in natural gas, except possibly in negligible traces.

The only practical way to remove products of combustion in gas stoves is by means of a vent leading to the house chimney.

Copies of Technical Paper No. 9 may be obtained by applying to the Bureau of Mines, Washington, D. C.

XUM

Catalog Notes

NOVALUX Street Lighting Units for Mazda Series Lamps, Bulletin Y-681, superseding Bulletins Y-527 and Y-529, was recently issued by General Electric Co.

SPECIFICATIONS FOR Westinghouse Type C controllers for steel mill and crane service are given in Descriptive Leaflets 3805, 3806 and 3807.

FROM HAUCK MFG. CO., Brooklyn, N. Y., we have received Bulletin No. 60 illustrating Hauck burners for removing and replacing crank shaft pins, machine shop repairs, melting babbit out of bearings, steel car repairs and other uses.

OPERATION OF the Copes boiler feed regulator is shown graphically in a new booklet with illustrations from photographs of an exhibit board especially constructed for the purpose. The manufacturer is Erie Pump and Equipment Co., Erie, Pa.

BRUCE-MACBETH Gas Engines and some Valuable Facts about Gas Power, a booklet just issued by the Bruce-Macbeth Engine Co., 2108 Center St., N. W., Cleveland, O., gives in concise form the principal advantages of gas power, together with some facts and figures regarding the results Bruce-Macbeth gas engines are giving in different kinds of service. It also contains sections on Producer Gas Plants, Bruce-Macbeth Engineering Service, How to Obtain Maximum Efficiency from Gas Power Plants, Meriam Steam Process, the new process discovered by J. B. Meriam, engineer and designer of The Bruce-Macbeth Engine Co., whereby low pressure steam for heating and industrial purposes can be generated as a byproduct by the ordinary gas engine; also a section of Gas Engine Data for the operators of gas power plants. The booklet is illustrated throughout with reproduced photographs of Bruce-Macbeth installations.

THE BUREAU OF STANDARDS, of the Department of Commerce, has just issued a publication, Scientific Paper No. 256, dealing with the construction of 4 standard ohms. This unit was defined by the London Congress as the electrical resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice, 14.4521 grams in mass, of a constant cross-sectional area and of a length of 106.3 centimeters. The work done at the Bureau of Standards consisted in the construction of material standards representing the unit realized in the form of mercury columns in glass tubes, and the work involved measurements of the highest accuracy of the length, the departure from uniformity of the cross section and the mercury content of each tube, as well as their comparison with working standard. All measurements had to be made at the melting temperature of ice prepared from specially purified water which was used in order to avoid any temperature uncertainty due to possible impurities in the ice. Electrical comparisons of the 4 standards showed the average deviation of their individual values from their mean value to be less than 0.000,001 ohm. Copies of the publication referred to may be obtained without charge from the Bureau of Standards, Washington, D. C.

PRACTICAL ENGINEER

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POSITION WANTED—By young man with 10 years' practical experience from boiler room up. Hold first class Massachusetts engineer's license. Will go anywhere. Am total abstainer and can furnish A1 references. Address Practical Engineer, Box 393, Chicago, Ill. 10-15-1

POSITION WANTED—By man 26 years of age. Have had 28 months' experience as general man around stationary power plant, and 2 yrs. running traction engine; also hold fireman's license. Reference will be furnished to any one wishing to correspond with me concerning position. Address Geo. M. Bucey, 1614 O St., Lincoln, Neb. 9-15-1

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POSITION WANTED—Stationary Operating Engineer, age 27 years, quick learning and a hustler wants position with a Mechanical or Electrical Engineer or Concern, with chance for advancement. Address Practical Engineer, Box 407, Chicago, Illinois. 10-15-1

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WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Calif.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Calif.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

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WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put in on test at our expense with any grate made. Address Armstrong Mfg. Company, Springfield, Ohio. tf.

WANTED—Engineers and Salesmen to demonstrate and take orders for Pulle-Y-Grasp during spare hours on commission. Send for sample. Address Desk P. E., Cardinal Mfg. Co., Cleveland, Ohio. tf.

For Sale

FOR SALE—Engines: 16x36 Buckeye medium speed automatic engine, overhauled, $350. 14x24 Murry slide valve throttling engine, $150. 13½x15 Taylor automatic slow speed engine, $200. 10x24 Hewes & Phillips Corliss engine, $275. 16x30 Allis heavy duty Corliss engine, practically new, $750. 150-hp. HRT boiler, 125 lb. steam pressure, $400. Duzets & Son, Hudson Terminal Bldg., New York. tf.

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Education and Instruction

ENGINEERS' POCKET MANUAL; 175 pages; gilt edges; bound in leather; edited by University of Tennessee; will be mailed every subscriber sending in one NEW subscription (not your own) to Practical Engineer.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine. If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill.

Inventions

INVENTIONS commercialized on cash and royalty basis. Inventors and manufacturers should write Adam Fisher Mfg. Co., 2175 Railway Exchange, St. Louis, Mo. tf.

Sparks From The Advertising Pages

Agencies for good are often tainted with incongruities and evils. Thus, within the realm of charity we find graft—within the world of science we find "fakes"—within the science of religion we find hypocrisy—within the field of commerce we find greed and within the realm of the publishing business we find one great evil, that of the oft-repeated free publicity granted through what should be exclusive editorial pages.

Newspapers have no monopoly on this maleficent affliction. Magazines and trade-journals are notoriously subject to this form of evil.

Mark you, however, this is no contention that descriptive writeups are not legitimate and necessary under proper circumstances, but the publishing of a writeup with such frequency that it is no longer a service rendered the reader, but rather a bait to procure or hold advertising, is a violation of the ethics of the publishing business.

These sugar-coated doses of pure advertising doled out in the form of reading notices as frequently as the whims of the publisher will allow, or the space permit, are not conducive to the proper relationship that should exist between the publisher and his subscribers.

Some publishers of today are doing the publishers of tomorrow and their constituencies a great service in establishing a quarantine on this sort of nuisance by using the serum which is a proven specific—that of barring free advertising from the editorial columns.

This is a standard of ethics that subscribers and advertisers respect and commend. No fair-minded advertiser can have confidence in a publication which will give him something for nothing—partiality is one of the detrimental elements entering into this question—no conscientious reader can have faith in a publication that gives him a "re-hash" of a writeup he has read in some previous issue.

To have each newspaper—each magazine—each trade-journal free of this "taint" is surely a "consummation devoutly to be wished."

This has always been one of the policies in the management of Practical Engineer. The same service—the same attention is available to each subscriber—each advertiser—no partiality whatsoever is shown in either class. What is published in its editorial columns is newsy and of importance to the engineer—what is printed in its advertising pages is reliable and always a safe buy.